Towards a framework for the adoption of a digital value chain for emerging small-scale farmers in South Africa

Hermanus Jacobus Smidt

Student #: 8403164

A thesis submitted in fulfilment

of the requirements for the degree of **Doctor of Philosophy**

in the **Department of Information Systems**

Faculty of Economic and Management Sciences

University of the Western Cape

Supervisor: Professor Osden Jokonya

August 2023

Plagiarism Declaration

Declaration

Hereby I, Hermanus Jacobus Smidt, declare that *'Towards a framework for the adoption of a digital value chain for small-scale farmers in South Africa'* is my original work and that all sources have been accurately reported and acknowledged, and that this document has not previously in its entirety or in part been submitted at any university in order to obtain an academic qualification.

Full name: Hermanus Jacobus Smidt Date: 12 August 2023

Signature: Smidt

Approved by

Supervisor name: Professor Osden Jokonya
Main Supervisor

……………………..

Abstract

Small-scale farmers experience significant institutional and governance challenges when applying digital technology. This is affected by a variety of political, social and economic factors. It is critical to comprehend why some actors in digital agricultural value chains (AVCs) profit more than others and how this trend manifests itself locally. The study conducted a literature review on Digital for Development (D4D) in small-scale farmers, identifying gaps in knowledge, generating new ideas, avoiding duplication, and justifying the relevance of the research. The objective is to address asymmetric knowledge communication and enhance the equal distribution of power and economic wealth in the digital AVC. To analyse how small-scale farmers use digital technology, theories from many different fields were merged using the Transformative Emancipatory Paradigm (TEP). This study proposes a framework for the adoption of a digital value chain for small-scale farmers. This study suggests a framework for the creation of organisations like District Agro-Food Sustainable Knowledge Hubs (DASKHs) and Provincial Agriculture Digital Innovation Hubs (PADIHs). Small-scale farmers are encouraged by the framework to adopt digital technology in their AVCs. To validate the framework, this study used a sequential explanatory mixed methods research design. The framework was improved using a quantitative method in the first validation, and interviews were employed in the second validation phase. The quantitative and qualitative results were combined to produce the final, refined framework. Findings demonstrated the importance of the state's role in governance and institutional support for fostering cooperation and involvement among various actors. PADIHs and DASKHs also develop unemployed graduates and young people as technopreneurs and agripreneurs. This study contributes to the D4D literature because South Africa arguably lacks such a framework. An alternative conceptualisation of a framework for the adoption of digital AVCs is provided in response to the study questions. It provides a clearer picture of the empowerment small-scale farmers have when using a digital AVC. This makes it easier for future D4D researchers, practitioners and academics to plan, conceptualise and carry out their research on digital AVCs.

Keywords:

Digital for Development, Digital Transformation, Transformative Emancipatory Paradigm, Small-scale farmer, Resilience Attributes, Mixed Methods, value chains, institutions, innovation hubs

Acknowledgements

I wish to express my profound gratitude to the following people for their assistance towards the completion of my thesis:

1. My promoter, Prof Osden Jokonya, from the University of the Western Cape (UWC) for his excellent academic guidance, motivation and support. I thank him greatly for imparting some of his knowledge and expertise in Digital for Development research aspects to me.
2. All the small-scale farmers' stakeholders, who assisted me with the documents, information and study-related interviews. I thank you all for your contribution, advice and support during the research work.
3. I also thank my co-supervisors for my Master's degree, Dr Ina Conradie and Prof Stephen Devereux, for encouraging me to register for my PhD degree.
4. Special thanks to my wife Mildred, and my children, Gershon, Thalea and Clio, for their support.
5. To my beloved parents, my late father, Mr. Godfrey Moses Smidt, and my mother, Mrs. Magaret Angeline Smidt, for their encouragement and support.
6. To all the people who have contributed to my thesis one way or the other but whose names I have not mentioned.

Dedications

This thesis is dedicated to my, wife Mildred Wilhelmina (nee Isaacs) Smidt, father, Mr. Godfrey Moses Smidt, my mother, Mrs Angeline Margaret Smidt, my children, Gershon, Thalea and Clio, plus the rest of the Smidt Clan.

Publications

The following publications emanated from this research.

- Smidt, H.J., & Jokonya, O. (2023). A framework to develop technopreneurs in digital agriculture value chains in South Africa. *Journal of Foresight and Thought Leadership, 2*(1), a21. https:// doi. org/10.4102/joftl.v2i1.21
- Smidt, H.J. & Jokonya, O., 2022, 'Towards a framework to implement a digital agriculture value chain in South Africa for small-scale farmers', *Journal of Transport and Supply Chain Management* 16(0), a746. https://doi.org/10.4102/jtscm.v16i0.746
- Hermanus Jacobus Smidt and Osden Jokonya. 2022. Towards a Philosophical Transformative Emancipatory Approach to do Digital for Development (D4D) research in South Africa". Chapter in the book "Digital Transformation" edited by Antonella Petrillo, Fabio De Felice, Monica Violeta Achim and Nawazish Mirza. (Accepted and to be Published by IntechOpen).
- Hermanus Jacobus Smidt & Osden Jokonya (2021): Factors affecting digital technology adoption by small-scale farmers in agriculture value chains (AVCs) in South Africa, *Information Technology for Development*, DOI: 10.1080/02681102.2021.1975256

Assignment posted on the website as one of the five best:

- Smidt, H.J. (2023). *Digitalisation for Sustainability (D4S) for Small-scale farmers in South Africa.* Assignment for an Interactive Doctoral Courses for Sustainability (IDOCOS) course titled 'Implementing digital transformation for sustainable development', hosted by European University Alliances

List of Tables

List of Figures

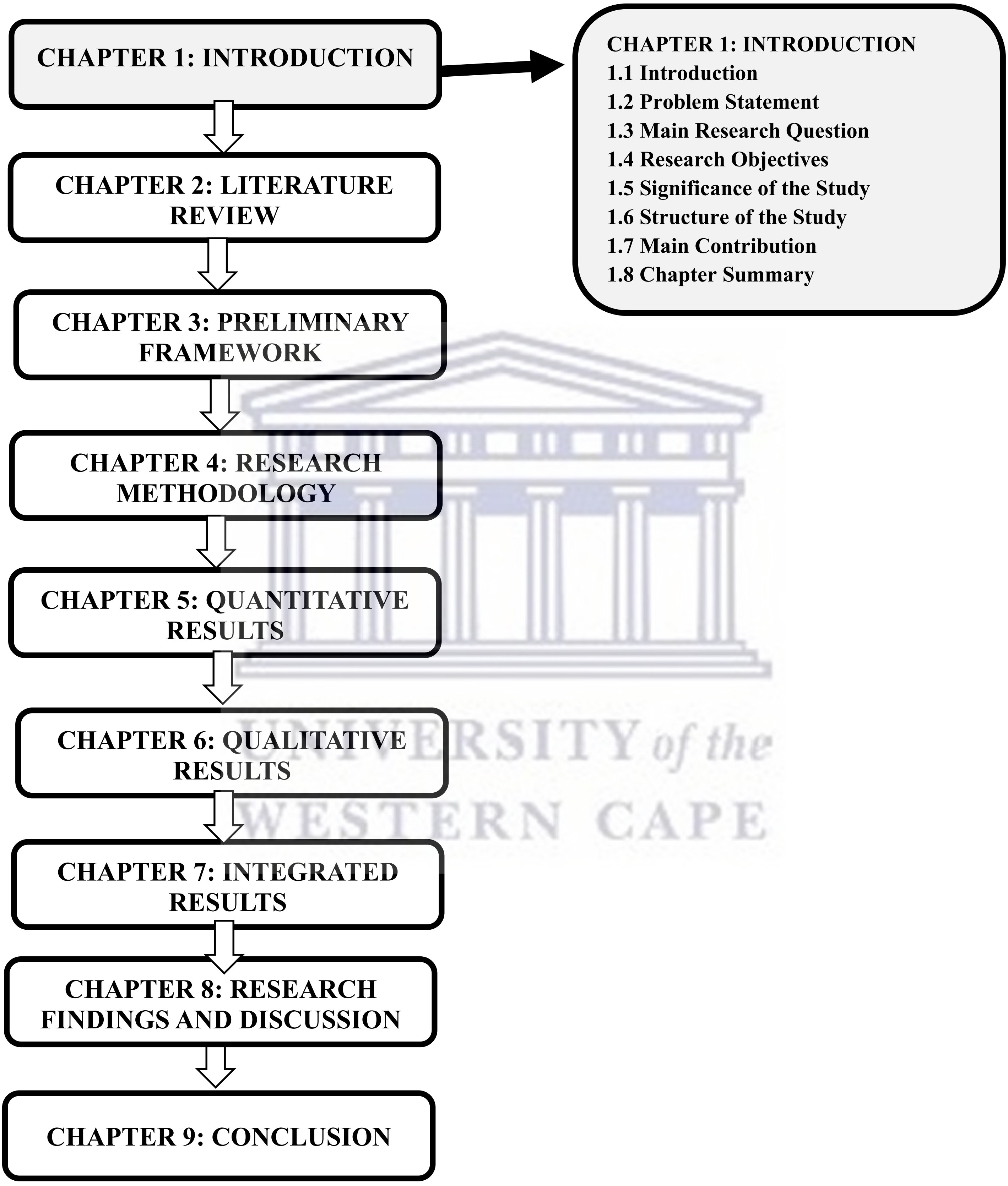
List of Acronyms

Abbreviations	Description
ANT	Actor-Network Theory
APAP	Agricultural Policy Action Plan
AVC	Agricultural Value Chain
AgTech	Agriculture Technology
ANOVA	Analysis of Variance
ADMIT	Architecture Design Methodology for Information Technology
CA	Capabilities Approach
CF	Choice Framework
CSR	Corporate Social Responsibility
DOI	Diffusion of Innovation Theory
D4D	Digital for Development
DASKH	District Agro-Food Sustainable Knowledge Hub
DCD	District-Centred Development model
EF	Evaluative Framework
GVC	Global Value Chain
GT	Grounded Theory
ICT4D	Information Communication Technology for Development
iNeSI	iKamva National E-Skills Institute
ICT	Information Communication Technology
ICT	Information Communication Technology
IT	Institutional Theory
NDP	National Development Plan
NDE	New Digital Economy
NGP	New Growth Path
PADIH	Provincial Agriculture Digital Innovation Hub
PCPDSP	Policy on Comprehensive Producer Development Support
RABIT	Resilience Assessment Benchmarking and Impact Toolkit
SME	Small and Medium-sized Enterprise
SPSS	Statistical Software for Social Sciences
SDG	Sustainable Development Goal
SLF	Sustainable Livelihoods framework
SSCM	Sustainable Supply Chain Management
TA	Thematic Analysis
TOE	Technology Organisation Environment Theory
TEP	Transformative Emancipatory Paradigm

Table of contents

`

CHAPTER 1: DIAGRAMMATIC OVERVIEW



Chapter 1: Introduction and background to the study

1.1 Introduction

Agricultural production and the value chain, including post-harvest, transportation and storage, are both improved by advances in digital technology (Corallo, Latino & Menegoli, 2018). Food safety issues can be contained, and consumer confidence is increased thanks to the use of digital technology in food traceability systems, which has become a highly essential risk management tool (FAO & ITU, 2016). Information Technology Communication (ICT)-enabled marketing helps businesses become more efficient internally and more competitive outside (Corallo, Latino & Menegoli, 2018). According to FAO (2015), digital technology can bring about suitable reforms for enhancing Agricultural Value Chain (AVC) access for small-scale farmers. Digital for Development (D4D) increases knowledge through new means of offering extension services (Deichmann et al., 2016). The term "D4D" refers to the necessity for digital technology to serve as a platform for social, political and economic revolution (Heeks, 2016).

1.1.1 The Concept of a Small-scale farmer in South Africa

Smallholder farmers in Africa play a crucial role in the rural economy and natural resource conservation, despite facing challenges like lack of capital. They are included in poverty reduction efforts and are being encouraged by African leaders to increase public expenditure on agriculture for economic development. Smallholder agriculture will drive economic growth and development in Africa, but adequate investment should focus on eliminating these challenges (Kamara et al., 2019).

In South Africa, the term "small-scale" agriculture is often associated with black farmers, who are often seen as backward and non-productive, especially in former homeland areas. The Department of Agriculture should define these farms for policy purposes and improve services. Small farmers need government assistance to increase productivity and should be empowered to form a vibrant agricultural sector. However, the term "small-scale" farmer often refers to any agricultural activity (Kirsten & Van Zyl, 1998).

The South African agricultural sector has shifted from a predominantly white commercial sector to a black-focused one, focusing on smallholder farming. Despite government efforts, smallholder farmers remain vulnerable, especially during droughts. The Western Cape classification system is criticized for its lack of support for these farmers. Remote rural communities limit access to markets and job opportunities. The government aims to improve the rural sector since 1994, focusing on capacity building for smallholder farmers to achieve food security, job creation, and income generation. The Western Cape Department of Agriculture suggests farm-level support services and an understanding of farmer livelihoods and resource endowment (Ncube, 2018).

Smallholder agriculture in South Africa is a key tool for poverty reduction and rural development. Social grants, particularly old age pensions and child support grants, significantly influence the livelihood strategies of many smallholder farmers in former homeland regions. However, only a small number of households can market their produce, with essential characteristics including labor market attachment, higher family labor usage, and access to credit (Pienaar & Traub, 2015). Land reform in South Africa should focus on the rural poor and smallholders, rather than emerging commercial farmers. The term "smallholder" overlooks inequalities and class-based differences within the large population of households engaged in small-scale agricultural production. A class-analytic perspective should focus on "petty commodity production" and "accumulation from below" to understand the diverse trajectories of small-scale agriculture within capitalism. This approach could lead to a significant increase in black small-scale capitalist farmers, who would play a leading role in reconfiguring the dualistic and racialized agrarian structure, competing with large-scale commercial farmers in domestic and export markets (Cousins, 2011).

The commercial viability of small-scale farmers in South Africa is often unclear, affecting various groups such as emerging, black, white, subsistence, small plot, disadvantaged, and low turnover farmers. The term "small-scale" farmer is often defined based on agricultural activity, but this can negatively affect profitability. Factors like specific farming enterprise and managerial ability should be considered, as turnover determines farm size categories, not land size. (Kirsten & Van Zyl, 1998).

1.1.2 The Concept of a Value Chain

The Value Chain of a company is a crucial part of a larger value system, involving businesses upstream and downstream. It includes infrastructure, human resources, technology, and information flow. The five main criteria for determining potential possibilities and risks are competitive rivalry, supplier bargaining power, substitutes' threat, new competitors' threat, and buyer bargaining power. The actions taken to provide value to customers form the value chain, reflecting strategy (Sealey, 2018; Abbasi, 2017). Value chain analyses emphasize the importance of superior delivered value, customer's perceived value, and lifetime value in supply chain management. Effective data use is crucial for medium-long-range strategies and short-term operational procedures. Understanding Ackoff's DIKW (Data, Information, Knowledge and Wisdom) hierarchy is essential for value chains, and digital transformation involves real-time data transformation (Ribeiro, 2021; Kumar & Rajeev, 2016). Digital transformation is a reengineering process that integrates technology to foster real-time vision throughout the value chain, increasing productivity and competitive advantages. This includes inbound logistics, operations, outbound logistics, sales and marketing, and post-sales services. Farmers must align their business plans with digital technology systems to effectively utilize these systems. Understanding best practices and procedures to convert data and information into knowledge is a major challenge in this process.

Small-scale agriculture is essential for reducing poverty, and commercial AVCs are a typical strategy for small-scale agriculture development (ITU, 2016). To support small-scale commercial production, South Africa's National Development Plan (NDP), which was released in 2012, calls for increasing irrigated agriculture and cultivating underutilised land (NAHF, 2017). While using digital data to boost the marketing of food items and related processing phases, AVCs must abide by national and international regulations (Corallo et al., 2018). According to Boateng et al. (2017), internet applications and mobile phones are altering the way people communicate. Stugeon (2017) contends that the "New Digital Economy" offers opportunities for digitally driven solutions to many issues facing agricultural growth. There has been significant progress in discovering the possibilities for using digital technology in agriculture (FAO & ITU, 2017). The integration of digital technology with agriculture development enhances AVC efficiency and food production (Heeks, 2018). To address the issues affecting the South African small-scale agriculture sector, the value of information cannot be emphasised enough (SDSN, 2015).

Evidence from the literature indicates that many promising examples of good digital impacts on the growth of small-scale agriculture have frequently not been scaled up (Deichmann et al., 2016). Inequality and social exclusion may be addressed through new government policies that remove structural barriers to encourage inclusive innovation (Foster & Heeks, 2015). Yet, the digital gap, which is characterised by a lack of institutional capability and insufficient human development, can limit progress (Mago & Mago, 2015). Understanding why some actors in AVCs profit more than others and why this pattern locally replicates the worldwide pattern is necessary (Bukht & Heeks, 2018). The National e-Strategy of South Africa (DTPS, 2017) offers strategic guidance for developing an inclusive digital knowledge economy, yet there are barriers to inclusive innovation for small-scale farmers who are marginalised and at risk of being left behind (FAO, 2015).

The systems and procedures used to create, carry out and maintain the policy for the use of digital technology in small-scale agriculture should encourage grassroots creativity among low-income people (Foster & Heeks, 2015). A new technological revolution that can accomplish more is being supported by policymakers, but critics claim that social ramifications have been overlooked. According to Rose and Chilvers (2018), policymakers, financiers, technology companies and researchers should consider the opinions of both farming communities and the general public when establishing digital policy in the agricultural sector. Incorporating small-scale farmers into current AVCs via digital technology adoption through funding, improved training, better fertilizer and other strategies are some of these techniques (ITU, 2016).

Digitalisation in South Africa is crucial for economic progress but faces opposition due to personal boundaries and politics. It is essential to address societal issues like climate change, biodiversity loss, social polarization, and democracy decline. A reorientation towards sustainable change is needed. The South African government should adopt regenerative designs, promote circularity, and pursue economic resilience, digital sovereignty, and social equality to tackle digitalisation's challenges and impact on small-scale farmers (D4S, 2022).

Digitalisation is not providing solutions and requires a major reorientation towards sustainable change. Governance should adhere to regenerative designs, promote circularity, and pursue economic resilience, digital sovereignty, and social equality. Ethical criteria for digitalisation include cross-disciplinary approaches, governance models, and addressing power inequalities in low-income areas. External researchers dominate research activities, leading to data collection and knowledge appropriation, causing a "brain drain" and attracting outstanding academics to other positions (Dearden & Kleine, 2020).

In South Africa new ethical debates are needed to impact the ethics of Digitalization for Sustainability that emphasize the importance of digitalisation for social, economic, and political development, particularly for the disadvantaged. A comprehensive understanding of digitalisation's role in achieving decent living for all and a coordinated approach for digital sufficiency, repairability, circularity, and efficiency. (D4S, 2022). There is a need to understand the economic, political, and social transformation associated with digitalisation in small-scale farmers' AVCs in South Africa. A digital AVC framework that can suggest strategies and policies to overcome constraints to growth in the digital agriculture economy is needed to assist the South African Government.

This case study investigates the digital inclusion of small-scale farmers in the Western Cape. The sampling frame consisted of all small-scale farmers in the West Coast and Overberg District Municipalities. It explores innovative digital technology use in AVCs to increase resilience and evaluate the effectiveness of digital Digital for Development (D4D) interventions. Data was collected through surveys and interviews, with in-depth investigations revealing potential data gaps.

The sections of this chapter are as follows: Section 1.2 presents the problem statement for the study; Section 1.3 presents the primary research question; Section 1.4 presents the study objectives; Section 1.5 presents the significance of the study; Section 1.6 presents the chapter outline; Section 1.7 presents the main study contributions; and Section 1.8 presents the summary of the chapter.

1.2 Problem Statement

D4D could help the South African government more effectively achieve its agricultural goals. The government needs to understand that it has a part to play in reorienting and equipping agricultural advising and extension services so that they can better serve farmers with information and tools.

ICTs are becoming more deeply integrated into all aspects of development and are no longer just tools to enable aspects of development. Agriculture 4.0 seeks to improve efficiency within the AVC and improve food production (Heeks, 2018).

The development of small-scale agriculture would go a long way to transform the agrarian structure in South Africa still dominated by race. This could increase the number of black emerging small-scale farmers that can compete with large-scale mostly white commercial farmers in supplying both domestic and export markets (Cousins, 2013). Agricultural information and knowledge need to reach emerging small-scale farmers in South Africa (DAFF, 2016) and they lack knowledge about the nature of digital economy growth in AVCs (Heeks 2018). Government need to understand why some actors in a given AVC benefit more than others and why this pattern of a global level is replicated in local AVCs (Bukht & Heeks, 2018)

Information about digital AVCs is not reaching smallholder farms in South Africa and this leads them to have a lack of knowledge about the subject (DAFF, 2016; Heeks, 2018; SDSN, 2015). Digital AVCs create opportunities that can assist in addressing the lack of economies of scale, and access to land, credit and technology (Malan 2018). Digital technologies fill the information gap in AVCs as an enabler of trade, standards, traceability and integrity (OECD, 2019).

The South African government often fails to understand the reforms needed to overcome development constraints (Graham 2019; Juma 2019). Digital AVCs to improve agricultural production and promote food security should be promoted by the government (Mago & Mago 2015) by providing comprehensive support to small-scale farmers (NAHF 2017). In South Africa agricultural advisory services should be re-orientated and re-equipped with better knowledge and technologies.

A participatory strategy is required to address unequal power relations and consider local settings in policies that promote inclusive innovation, address inequality and combat social exclusion (Martin & Duncombe, 2017; Foster & Heeks, 2015). Exploring implications and identifying both positive and negative scenarios is necessary (Stugeon, 2017A multidisciplinary approach can be utilised to analyse the complexity of D4D produced by several constituencies with various opinions (Jokonya, 2016). A balance between openness and dominance among stakeholders must be achieved via governance frameworks that encourage the right kinds of motives for value creation (Constantinides et al., 2018). To prevent digital harm, collaboration is required to develop a digital policy for inclusiveness and sustainability (Heeks, 2018). The public sector needs to be held accountable for deploying technology that empowers the underprivileged, and digital dividends must increase skills (Deichmann & Mishra, 2019). More socially responsible innovation processes must result from implementing a development framework (Rose & Chilvers, 2018).

Making digital technologies accessible to as many small-scale farmers as possible would help stakeholders along AVCs to collaborate on digital policy, inclusivity, sustainability and prevention of digital harm (UNGC, 2019; Heeks, 2018). For small-scale agriculture in South Africa, there is a need for a comprehensive framework that includes the following elements: (i) a broadening of notions of inclusion in responsible innovation to account better for diverse and existing spaces of participation in agri-tech, and (ii) greater testing of frameworks in practice to see if they are capable of making innovation processes more socially responsible (Rose & Chilvers, 2018).

1.3 Main Research Question

To address the issues highlighted in the problem statement, the primary research question of the study is:

- What are the inhibiting factors against the adoption and use of technology by small-scale farmers in small-scale farmers South Africa?

The following sub-questions will help answer the main research question:

- What are the factors affecting the adoption of technology by small-scale farmers in agriculture-value chains of South Africa?
- What are the possible shortcomings of existing digital value chain frameworks that impede small-scale farmers' agriculture-value chains in South Africa?
- What are the properties of a digital value chain framework to improve small-scale farmers' agriculture-value chains in South Africa?
- How could a new digital value chain framework improve small-scale farmers' agriculture-value chains in South Africa?

1.4 Research Objectives

The aim of the research is to identify limitations and develop an improved digital value chain framework to assist small-scale farmers in agriculture-value chains in South Africa. The main objectives of this study are:

- To determine the factors affecting the adoption of technology in existing digital value chain frameworks of small-scale farmers in South Africa
- To demonstrate the need, identify limitations and propose a conceptual digital value chain framework to assist small-scale farmers in the agriculture-value chains of South Africa.

- To develop an improved digital value chain framework to assist small-scale farmers in the agriculture-value chains of South Africa.
- To validate the developed digital value chain framework to assist small-scale farmers with the adoption of digital technologies in the agriculture-value chains of South Africa.

1.5 Overview of Theoretical framework and the Approach

This study examines the theoretical models used to explain small-scale farmers' adoption of digital technologies and their AVCs. It aims to provide a theoretical framework for data collection and avoid potential pitfalls from an economy-only perspective. Understanding and approaching technology development for precarious agricultural livelihoods requires a rethinking due to the complex constraints associated with technology adoption (Ospina et al., 2016).

The theoretical foundations of Digital for Development (D4D) for small-scale farmers focus on development theories, digital technology adoption theories, and transformative processes. It reviews the literature on D4D and digital platforms, addressing concerns and minimizing duplication. The implications of digital technology adoption for small-scale farmers and governance requirements for inclusive digital innovation platforms are clarified. The study integrates these concepts and constructs a theoretical framework, providing context for digital technology adoption and governance requirements for inclusive digital innovation platforms (Ospina et al., 2016; Zheng, 2007).

The study discusses the Capabilities Approach (CA) and the Sustainable Livelihoods Framework (SLF), which are development theories that focus on freedom of choice and valuation. It suggests that the CA and SLF can be used to develop a framework for adopting digital technologies in AVCs for small-scale farmers. The study also highlights the need to use the CA in conjunction with the SLF when analyzing or implementing digital transformation for small-scale farmers in AVCs. Sustainability refers to the ability of small-scale farmers to acquire resources for self-renewal. It further explores various digital technology adoption theories, including the Technological Organisation Environment (TOE) framework, Institutional Theory, Actor Network Actor-network Theory, and ADMIT Methodology for Information Technology. TOE explains how technological, organizational, and environmental factors influence small-scale farmers' adoption of digital technology, Institutional Theory explains necessary transformation, and Actor-network Theory connects adoption to various groups and institutions. Transformative theories like the Choice Framework, Evaluative

Framework, Diffusion of Innovation Theory, Porter's Value Chain, Carroll's Pyramid of Corporate Social Responsibility, and a Resilience Assessment Benchmarking and Impact Toolkit (RABIT) can be used to identify gaps and solutions.

This study aimed to assist small-scale farmers in AVCs by creating a digital AVC framework. After a quantitative phase, qualitative data was collected for an explanatory sequential mixed methods design analysis. A literature review was conducted to develop a working hypothesis and framework for D4D implementation in AVCs, using abductive inference.

The study used data collection to test a framework for digital technology adoption in AVCs for small-scale farmers. An inductive approach was used to improve the framework, while quantitative data was collected to clarify causal relationships. Large sample sizes and controls ensured validity and reliability. A series of qualitative interviews validated the updated framework, allowing for generalization and understanding of initial quantitative findings. Thematic Analysis was used to analyze data patterns and participants' opinions, views, and experiences. This exploratory process aligned with research objectives to validate the digital AVC for small-scale farmers.

1.6 Significance of the study

Although there are many studies on digital AVCs, there is still a knowledge gap across different countries and social groups (Heeks, 2018). With limited attention paid to poorer countries, evidence of significant transformative developments is primarily seen in high-income countries. To prevent favouring the wealthy over the poor, the digital technology that drives this new economy must also be better protected and governed (Graham, 2019). The role of digital technology adoption in global AVCs should be discussed in relation to discussions concerning small-scale farmers' use of digital technology at the farmer level. It is important to identify the economic, political and social elements influencing these socio-technical systems in order to begin this conversation. This underlines the necessity of understanding the current status of research.

Most research on digital AVC frameworks concentrates on benefits that may be difficult to attain and are not immediately apparent. A comprehensive framework is required to support small-scale farmers' engagement in current agri-tech markets through socially conscious innovation. Debatably, there has not been much research done on the significance of comprehending these barriers to expansion in South African digital AVCs or how to get overcome them. Opponents claim that social consequences have been overlooked and cast doubt on the viability of current frameworks in addressing this complicated issue.

The answer to the research question lays the groundwork for future studies on the significance of promoting creativity, training, collaboration and involvement. This study contributes to a better understanding of the policy gaps in the implementation of digital technologies for small-scale farmers in AVCs. How to make them better and how to ensure that small farmers' perspectives are heard during the policy-making process.

An alternative conceptualisation of a framework for the adoption of digital AVCs is presented in reply to the research question. This makes it easier for future D4D researchers, practitioners and academics to plan, conceptualise and carry out their research on digital AVCs. To better understand how farmers might be empowered to utilise digital technology in AVCs, this study contributes to the D4D research field. The response to the research question lays the groundwork for future studies on the significance of promoting creativity, training, collaboration and involvement.

1.7 Main Contribution

This study contributes to the D4D literature because South Africa lacks such a framework. An alternative conceptualisation of a framework for the adoption of digital AVCs is provided in response to the study questions. The study's primary contribution is the creation and validation of a framework for digital technology adoption in AVCs.

The framework's goal is to help small-scale farmers integrate digital technologies in AVCs. It provides a clearer picture of the empowerment small-scale farmers have when using a digital AVC. This makes it easier for future D4D researchers, practitioners and academics to plan, conceptualise and carry out their research on digital AVCs.

Additionally, it can help with a better understanding of the institutional setup required to promote the growth of technopreneurs in AVCs. A presentation at a global conference and publications in peer-reviewed international journals are among the study's further contributions.

1.8 Structure of the study

Chapter 1: *Introduction:* This chapter briefly introduces the study, research questions and its objectives. The chapter also provides the problem statement and significance of the study. In addition, the chapter provides an outline of the research in terms of chapters to follow.

Chapter 2: *Literature Review:* This chapter presents the literature that serves as the foundation for the development of a thorough conceptual digital technology adoption in AVCs framework for small-scale that is systemic, inclusive and socially responsible. This chapter discusses the theoretical underpinnings used for this research to understand how digital technology adoption leads to development. To prevent repetition and address the ideas and problems surrounding the subject, literature from the body of current knowledge was studied, expanded and applied to small-scale farmers in South Africa. The chapter offered some insights into the variables influencing small-scale farmers' current resilience and investigates how the digital technology adoption AVCs framework can improve this.

Chapter 3: *The Proposed Framework:* This chapter proposes a digital technology adoption in the AVCs framework based on the literature reviewed from the previous chapter. The proposed digital technology adoption in the AVCs framework is developed from theories of existing frameworks highlighted in the literature review. The chapter also highlights the expected benefits of the proposed digital technology adoption in the AVCs framework for small-scale farmers as part of its contribution to the body of knowledge in the research area.

Chapter 4: *Research Methodology:* This chapter discusses the research methodology and philosophy. It also articulates the rationale for selecting the research methodology in terms of suitability to address the research question and objectives. The research strategy, data collection methods and data analysis are also discussed. The description of the small-scale farmer stakeholders who participated in the study is also presented. The objective of the discussion of the research methodology is to guide how to validate the preliminary framework before it is refined into the final framework. Finally, the chapter highlights the ethical considerations and the study's limitations.

Chapter 5: *Quantitative Results:* This chapter presents the quantitative results of the first validation of the preliminary framework based on data from questionnaires. The chapter helped to refine the questions for the second qualitative phase. The results are discussed as part of addressing the research question.

Chapter 6: ***Qualitative Results:*** This chapter presents the qualitative validation results from interviews with participants from the small-scale farmer stakeholders. The qualitative validation results are a follow-up to the quantitative validation results. The qualitative results, therefore, helped to understand the quantitative results from the first phase.

Chapter 7: ***Integrated results:*** This chapter presents the integrated results from the quantitative and qualitative results. The chapter discusses the integrated results as part of refining the developed framework in Chapter 3. The chapter discusses the final framework after the conclusion of the integrated results is presented.

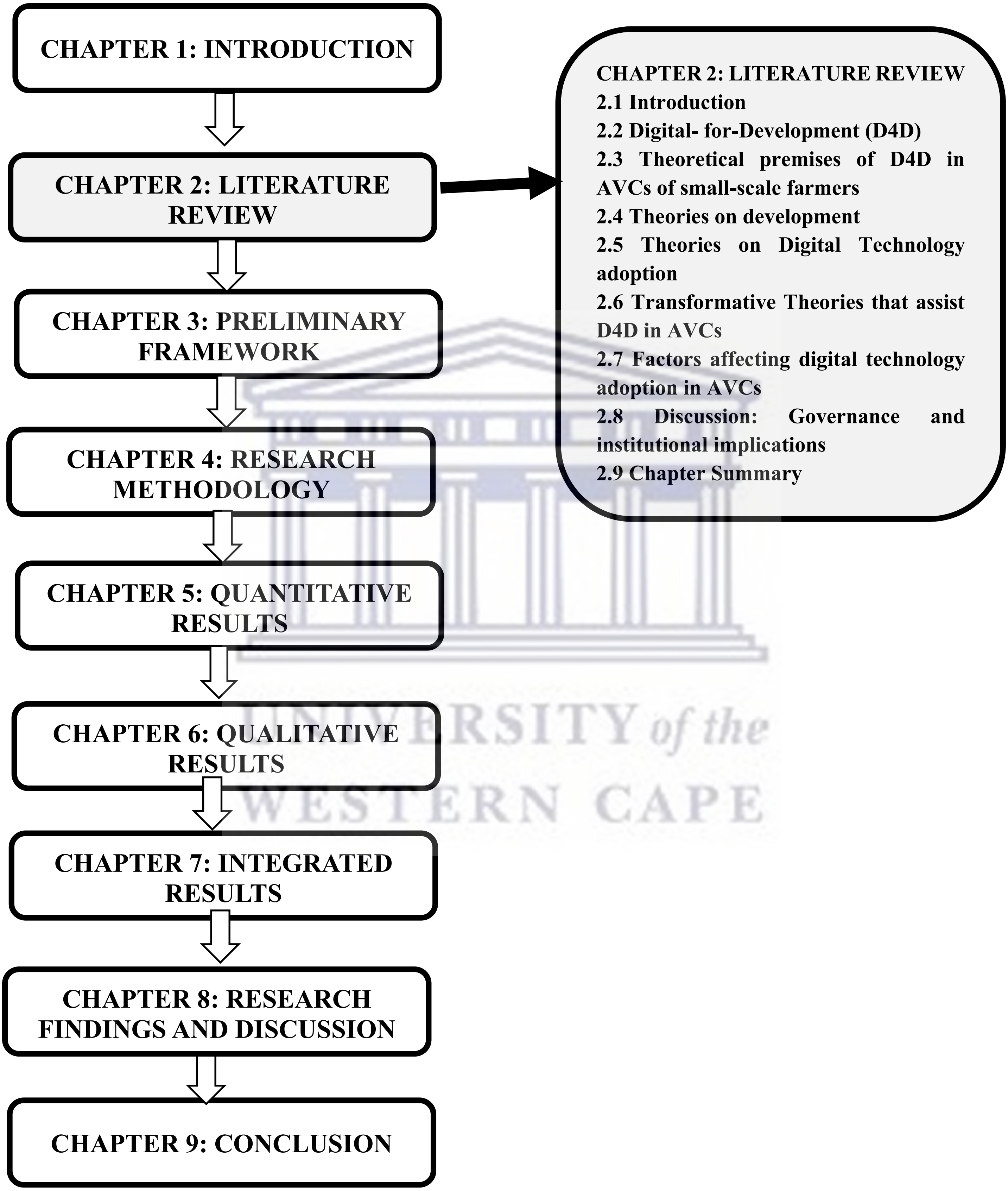
Chapter 8: ***Conclusion:*** This chapter discusses how the study meets the objectives and answers the research questions. The chapter also discusses the contribution of the study, makes recommendations based on the results and discusses the limitations of the study and future research areas.

1.9 Chapter Summary

This chapter examined the difficulties associated with implementing digital technology in AVCs from the viewpoint of small-scale farmers. While there is a wealth of material on the adoption of digital technology in AVCs from the viewpoint of the commercial farmer, there is not as much from the viewpoint of the small-scale farmer whose stakeholders have different worldviews. The chapter observed that the mechanisms now in place for adopting digital technology in AVCs might be inappropriate for making complex decisions about adopting digital technology to support small-scale farmers in AVCs.

The aim of this study is to provide a better framework as a result of the shortcomings of the current AVCs for small-scale farmers' digital technology adoption frameworks. The chapter also provided the study's importance and contribution to the field of study. The following chapter examines the body of knowledge regarding small-scale farmers' AVCs' usage of digital technologies.

CHAPTER 2: DIAGRAMMATIC OVERVIEW



2 Chapter 2: Literature review/ Theoretical framework

2.1 Introduction

The research area, the research objectives, the research question, the problem statement, the contributions of the research and the study design were all introduced in the previous chapter. This chapter reviews recent research on small-scale farmers' adoption of digital technologies in agriculture value chains (AVCs). This chapter's goal is to respond to the first research sub-question "What are the economic, political and social factors that affect the adoption of digital technology in AVCs of small-scale farmers?" The answer to this question entails locating, realising and evaluating any advantages or disadvantages that these elements may have on the growth of small-scale farmers to adopt digital technology in their AVCs. It lays the groundwork for the consequences of institutional and governance issues that influence policy decisions about the implementation of a digital AVC for small-scale farmers.

The United Nations (UN) established the 2030 Agenda for Sustainable Development in September 2015, which outlines 17 Sustainable Development Goals (SDGs) spanning the social, economic and environmental factors (SDSN, 2015). The growth of small-scale agriculture adds to long-term food security and affects the following three SDGs: SDG-ending poverty, SDG2-achieving zero hunger and SDG12-sustainable consumption and production (FAO, 2015). The African Union (AU) adopted Agenda 2063 in 2013, with Goal 5 calling for the modernisation of agriculture in Africa to increase productivity (AUC & AUDA-NEPAD, 2020). The objective was to improve the weak AVCs of South Africa's flows from the National Development Plan (NDP) launched in 2012. The NDP advocates that growing irrigated agriculture, using underutilised land and facilitating commercial production could result in the creation of new jobs in the agricultural sector (NAHF, 2017).

Small-scale agricultural growth could alter South Africa's agrarian system and increase the number of small-scale farmers competing to supply both domestic and export markets (Cousins, 2013). Agriculture 4.0, which integrates digital technologies into all facets of development, aims to increase productivity within AVCs and boost the food supply. Small-scale farmers need access to agricultural information and education because they are unaware of the characteristics of digital AVCs (Heeks 2018; DAFF, 2016). The government must comprehend why some value chain participants profit more than others (Bukht & Heeks, 2018).

Agriculture is essential for reducing poverty, and commercial AVCs are a popular strategy for agriculture development (ITU, 2016). AVCs must abide by national and international regulations and thus use digital data to boost the marketing of food items and related processing phases (Corallo et al., 2018). According to Boateng et al. (2017), internet applications and mobile phones are altering the way small-scale farmers communicate. Stugeon (2017) contends that the "New Digital Economy" offers chances for digitally driven solutions to many issues facing agricultural growth. There has been significant progress in discovering the possibilities for using digital technology in agriculture (FAO & ITU, 2017). Integration of digital technology into agriculture development enhances AVC efficiency and small-scale farmers' ability to produce food (Heeks, 2018).

The digital divide in agriculture is characterized by inefficient knowledge interchange, poor information content management, and constrained institutional and human capabilities, which could restrict improvements (Mago & Mago, 2015). Numerous encouraging cases of the beneficial effects of digital technology on agriculture development have frequently not been scaled up (Deichmann et al., 2016). By removing structural barriers that hinder inclusive innovation, new government policies could reduce inequality and digital exclusion (Foster & Heeks, 2015).

To grow small-scale agriculture in rural regions, there must be a strong political will. Working with rural women, indigenous communitiesand youth and other marginalised and at-risk groups is part of this (FAO, 2015). Small-scale farmers must integrate to achieve economies of scale to take advantage of AVC opportunities. Heeks (2016) makes the case that Digital for Development (D4D) produces socio-technical systems with the ability to significantly lessen the difficulties experienced by small-scale farmers in developing nations. To ensure that small-scale farmers are not left behind in the wake of these new digital technology drivers, D4D developed a reaction (Thapa & Omland, 2018).

As numerous social ramifications have been disregarded, officials in both the agricultural and digital technology sectors must promote this new technological revolution employing D4D. The role of digital technology adoption in global AVCs and the exploration of the role of digital technology adoption at the farmer level should be the focus of discussions on small-scale farmers' use of digital technology in AVCs.

The economic, political and social aspects affecting these socio-technical systems must be identified to begin this discussion. There is a necessity of understanding the present state of research by highlighting information gaps, similarities and discrepancies among the many AVC components. The following is the order of this chapter: Section 2.2 examines ‘Digital-for-Development’, Section 2.3 discusses ‘Theoretical premises of D4D in AVCs of small-scale farmers’, Section 2.4 discusses ‘Theories on development’, Section 2.5 discusses ‘Theories on Digital Technology adoption’, Section 2.6 discusses ‘Transformative Theories that assist Digital for Development (D4D) in AVCs’, Section 2.7 discusses ‘Factors affecting digital technology adoption in AVCs’, Section 2.8 discusses ‘Governance, institutional implications, collaboration and participation’ while finally Section 2.9 gives a chapter summary.

2.2 Digital- for-Development (D4D)

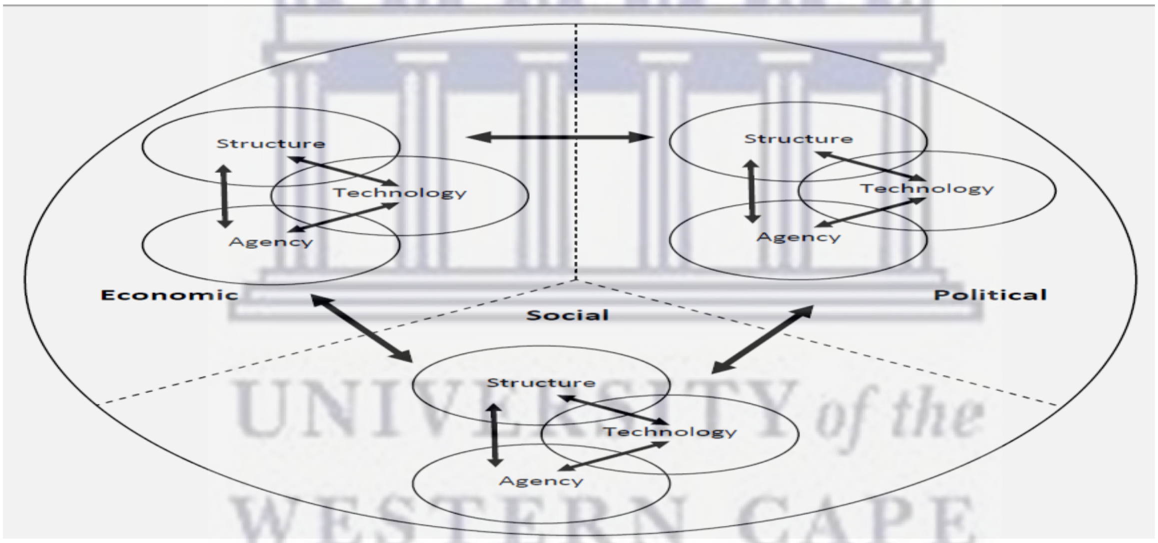


Figure 2-1: Conceptual framework for Digital-for-Development (D4D) (Source: Heeks, 2016)

D4D is defined as socio-technical systems where society and technology are intertwined and influence one another. D4D are three interconnected systems that function inside society and are engaged in the creation, application and management of D4D. In D4D, digital processes will predominate, and humans will play a variety of roles in their interactions with digital technologies. D4D thereby increases their dependence and vulnerability at the same time (Heeks, 2016). Figure 2-1 depicts how people use technology to influence both agency and structure, which in turn influence the organisations and institutions of society. Increasing digital access can aid the world's poorest by bringing people together (Graham, 2019).

The impact of D4D can be measured using one of three perspectives that conceptualise development as being economic, livelihood, or capability. Governments must scale up transformation to ensure that everyone has access to opportunities and benefits without jeopardising the ability of future generations to meet their needs (Heeks, 2016). The study's objective is to provide a framework for digital technology adoption in AVCs that will assist D4D for small-scale farmers in South African. Then, to give further context, the history of D4D is first examined.

2.2.1 The History of Digital-for-Development (D4D)

Three phases led to the gradual transformation of the connection between digital technology and global development.: ‘Pre-digital’, ‘ICT4D (Information Communication Technology for Development)’ and ‘D4D’ (Heeks, 2020). During the Pre-digital phase, digital technologies’ impact in developing countries was severely limited due to the high cost of acquiring technology (Cripe, 2018). Although digital technologies were increasingly available, it was ignored by the development mainstream (Heeks, 2020).

The transition from the pre-digital phase into the ICT4D paradigm was marked by using digital technologies (mobile and internet) more frequently to make it possible to impact significant change in developing nations (Cripe, 2018). With the signing of the Millennium Development Goals (MDGs) in 2000, digital technologies were integrated into the delivery of development as a tool to attain those goals (Heeks, 2020).

The adoption of the Sustainable Development Goals (SDGs) in 2015 resulted in a clearer focus on transformation, inclusion and sustainability. This also altered the connection between development and digital technologies (Heeks, 2020). This D4D phase saw a change in the philosophy of ICT4D where citizens of developing nations became content creators and not only passive consumers. This philosophy and approach form the backbone of the belief that D4D could contribute to self-sufficiency. This was an important step towards using digital technologies to raise the standard of living for those who are most vulnerable (Cripe, 2018). D4D uses and applies digital technology tools for social, economic and political development to support the most vulnerable (Sein et al., 2019).

Connecting people should help the world’s poorest through increased digital access. Although digitalisation of development develops more efficient and effective processes, it can also create inequalities that lead to social justice issues (Heeks, 2020). Thus, this evolution of digital technologies that impact the ethics of D4D demands new ethical debates. The Principles of D4D were designed to ethically guide digital technology implementations. It was developed by implementers, practitioners and donors through a working group. It shares good practices that can serve as guidelines when the impact of D4D is researched. The nine guiding principles are: Design with the User; Understand the Existing Ecosystem; Design for Scale; Build for Sustainability; Be data-driven; Use open standards; reuse and upgrade; Avoid Harm and Work Together (PDD, 2021).

It is important to keep in mind that initially, digital technologies had little to do with growth. Subsequently, digital technology evolved into a tool for development delivery. Digital technologies have emerged as a platform for citizens to drive development in the present D4D phase, with a strong focus on transformation, inclusion and sustainability of the most vulnerable. To address social fairness and injustice, new ethical discussions are necessary. It is crucial to comprehend the New Digital Economy before moving on to talk about the concepts of a digital platform.

2.2.2 Digital Platforms and the New Digital Economy (NDE)

The New Digital Economy (NDE) refers to the economic output of digital technologies based on digital goods or services (Bukht & Heeks, 2018). Big data analytics, cloud computing, artificial intelligence, robots and factory automation, as well as new data sources from mobile and ever-present Internet access, are all part of the NDE (Stugeon, 2017). The NDE is made up of value-generating digital information services that enhance, replace or complement economic interactions in an increasing number of value-creating processors (Graham, 2019).

In developing countries, some of the key challenges are the unequal distribution of digital resources, processes, benefits and harms across various social dimensions of the NDE (Heeks 2018). Thus, research needs to inform strategic thinking across both social and business indicators (Constantinides et al, 2018). The most important questions are: Who controls, owns and has access these new modes of economic production (Graham, 2019)?

Digital platforms are a collection of digital resources that enable interactions between external producers, consumers and third-party players to create value (Constantinides et al, 2018). The NDE extends the organisational and geographical fragmentation of work, and the impact on jobs depends on the pace of change and the ability of organisations and societies to manage it (Stugeon, 2017). The digital platform may not include any physical assets, but it adheres to a model of the platform ecosystem that places an emphasis on key interactions between platform users. Digital platforms are developed on top of digital infrastructures that enable various stakeholders to coordinate their service and content needs (Constantinides et al, 2018).

The effects of the NDE on society as a whole need to be examined, along with potential benefits and drawbacks (Stugeon, 2017). There is still a knowledge gap across countries (Heeks 2018), since evidence of significant transformational shifts is primarily found in high-income northern countries, with little attention given to the poorer southern economies (Graham, 2019). Strong innovation ecosystems can be built using digital platforms, and these ecosystems can contain governance principles that let platform users create value for one another (Constantinides et al, 2018). Digital information, as one of the NDE's fuels, needs to be better protected and regulated to prevent favouring the wealthy over the poor (Graham, 2019). Thus, next the importance of governance of digital platforms is discussed.

2.2.3 Governance of Digital Platforms

Given that digital technology as an enabler may appear promising in the near term while underlying issues persist, attention must be paid to the significance of governance of digital infrastructures and platforms (Deichmann & Mishra, 2019; Constantinides et al., 2018). The motivations and ramifications of the many stakeholders, including platform clients and platform workers, need to be better understood (Constantinides et al, 2018).

In South Africa, there are many policies and pieces of legislation that attempt to unlock the potential of digital technologies to alleviate poverty and reduce inequality (South Africa, 2016). To comprehend the growing complexity brought on by many stakeholder constituencies with various worldviews, D4D necessitates a multidisciplinary approach (Jokonya, 2016a). Digital dividends should concentrate on enhancing the business climate, enhancing skill development, and holding the public sector accountable to ensure technology helps the underprivileged (Deichmann & Mishra, 2019).

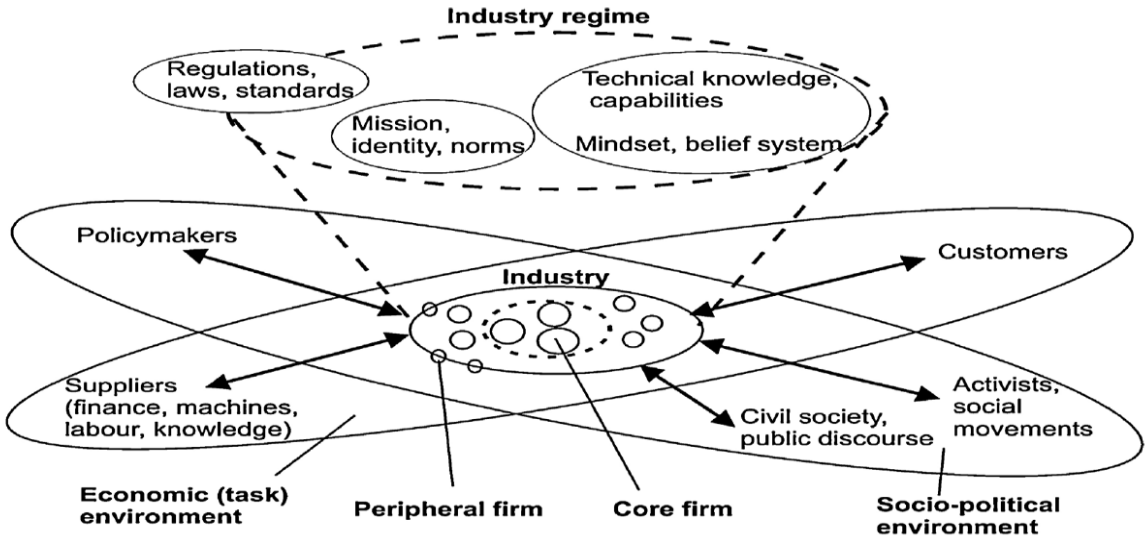


Figure 2-2: Triple Embeddedness Framework (Source: Quinones et al., 2017)

Digital technology architecture establishes a strong foundation for creating platforms that can bridge industry boundaries (Constantinides et al., 2018) and are no longer constrained by local institutional contexts but instead enable the fusion of knowledge across sectors (Quinones et al, 2017). Figure 2-2 demonstrates the various industrial regimes, product and digital sector regimes and economic and socio-political settings that digital start-ups are interwoven in on a local and global basis.

Platform governance must therefore offer the proper incentives and frameworks for value generation while achieving a balance between openness and control among various stakeholders. The design rules must govern the relations of stakeholders in the platform ecosystem (Constantinides et al, 2018). Thus next, it is crucial to comprehend the need for digital technology adoption in AVCs for small-scale farmers.

2.2.4 The importance of D4D in small-scale farmers' Agriculture Value Chains (AVCs)

Agriculture is becoming knowledge-intensive, and imparting this knowledge can be difficult because it must be adapted to local circumstances (NAHF, 2017). By gaining information and removing geographical obstacles by connecting farmers and buyers, digital solutions in agriculture can increase access to commercial marketplaces (Krone & Dannenberg, 2018). Industry 4.0 suggests new approaches to produce, develop, sell and distribute food in South Africa, as well as new opportunities to address issues facing small farmers (Malan, 2018). Research has revealed a connection between D4D, small-scale farmers' livelihoods and the decrease in poverty. This connection can help D4D improve farmers' capacities and livelihoods (Mago & Mago, 2015).

Digital technologies are becoming compulsory for communication in AVCs and can lead to digitally driven exclusion based on small-scale farmers' characteristics and capabilities (Krone & Dannenberg, 2018). Low education might exclude them from potential benefits, and measures beyond regulation may be needed (Boateng et al, 2017). In any process of change, there will be forces that are radical and truly transformative, while there will be forces that are regressive to reaffirm current patterns and processes (Malan, 2018). South Africa can benefit from the transformative nature of D4D as there is a need to continuously revisit the question of inclusiveness.

In developing countries, there has been little research about digital enterprises (Boateng et al, 2017) as most previous studies focus on people with an existing "digital footprint" (Ndemo, 2019). To stop social injustices, understanding the role that small-scale farmers play in the New Digital Economy (NDE) is essential. For the growth of small-scale farmers in South Africa, a revolutionary structural and systemic change to the food system is required (Malan, 2018). By working together, the private sector, governments, communities and civil society have an opportunity to break down global inequalities (Pepper & Jackman, 2019). The government needs to facilitate interactions between ministries, higher research institutions and civil society actors for systematic advice support to develop government policy (Juma, 2019).

To achieve the SDGs globally, universal connectivity can be achieved (Ndemo, 2019) by ensuring access to the unconnected, improving connections for the under-connected and closing the connectivity gender gap (Pepper & Jackman, 2019). The mobile revolution must be implemented as an inclusive industrial transformation in South Africa (Juma, 2019). This will make sure that the benefits do not flow exclusively to those who have historically benefitted (Pepper & Jackman, 2019). The government needs to constantly monitor whether digital technologies increase existing inequalities, barriers and constraints (Graham, 2019). The government must implement policies where the private sector and civil society focus more on digital technology for development than on the development of digital technology (Unwin, 2019).

A developmental framework must be built for South African small-scale farmers to adopt a digital value chain. This can assist the South African government to develop a policy that would be effective for responsible Agri-4 innovation that has a systemic approach.

Technology is an integral component of daily life and is crucial to global progress (Sein et al., 2019). There is mounting evidence that the use of digital platforms and mobile technology could alter several AVC activities in developing countries (FAO et al., 2020; Ezeomah B. & Duncombe, 2019). Increasingly efficient and transparent digital tools can enable the voices of marginalised farmers to reach decision-makers everywhere (Sein et al., 2019). Economies are rapidly transformed by digital technologies that assist to increase production in agriculture to meet global challenges (FAO et al., 2020).

Although there is a need to accelerate the digital evolution of AVCs to ensure food security, it can also be disruptive (FAO et al., 2020). The introduction of new digital tools has not advanced at an equal pace as marginalised groups continue to be excluded. Small-scale farmers are not reaping the benefits of technological advances due to the stereotyping narrative that technology is only suitable for big industrial farmers. This is accompanied by the high cost of devices and data with a lack of role models. If this digital divide is not bridged, small-scale farmers would be left behind by this Fourth Industrial Revolution (Sein et al., 2019).

Digital technologies are crucial to link smallholder farmers as they are often fragmented and produce small quantities of raw material that are insufficient to supply small and medium processors. Although collaboration is vital to bring collective actions, this must be guarded against path dependency among actors (FAO et al., 2020). In Africa, low productivity rates in agriculture are often associated with low levels of technology utilisation. To transform African agriculture will depend on the policy environment that is created in response to these new digital technology drivers (Kariuki, 2011).

Thus, to know how digital technology can address agriculture challenges, it is important to understand how the digital divide affects AVCs within countries and globally. This can be used to inform policies and regulatory frameworks that can enhance the implementation of digital technology to contribute towards all dimensions of sustainable development (FAO et al., 2020). Therefore, the next section will examine the challenges for D4D research and implementation in AVCs.

2.2.5 Challenges for Digital for Development (D4D) Research and implementation

Who is driving and benefitting from D4D projects was a key topic of discussion at the 2019 International Federation of Information Processing (IFIP) Working Group 9.4 meeting. The aim was to establish whether the most vulnerable people are adequately included in the process (Walsham, 2020). It is not easy to understand how digital technology fosters development in underdeveloped communities (Sein et al., 2019).

When used by players in a social, political, cultural and technical environment, digital technologies can contribute to progress but cannot do so on their own (Thapa & Omland, 2018). Considering this, the relationship between inequality and digital technology needs to be re-evaluated. This resulted from a shift in the relationship between global development and digital technology. This broadens the scope of the worries about the digital divide and exclusion to include digital justice, which deals with negative incorporation into digital development systems throughout the fields of economics, politics and society (Heeks, 2020).

Existing methodologies and theories are biased towards approaches from the Global North and cause research paradigms in D4D to be a continuation of colonial control over the Global South (Walsham, 2020). This new challenge of "adverse incorporation" is defined as the process where powerful, connected people exploit others by dominating resources to earn higher returns at the expense of the excluded. The digital divide initially describe as a lack of access to digital technologies, now also includes the non-affordability and the lack of ability to use these digital technologies (Heeks, 2020). Thus, research might be able to explain how and why digital technology intervention leads to development by analysing these underlying issues (Thapa & Omland, 2018).

An example of adverse incorporation includes the integration of African small enterprises into digitalised global value chains, where gains are made by lead firms in the global North at the expense of those small enterprises (Heeks, 2020). Those with power and resources gain more from D4D than the marginalised. This study fully supports Walsham (2020) who argues for research that establishes who is driving and benefitting from D4D projects. Research should further interrogate if the marginalised are genuinely included and whether our philosophical paradigms, methodologies and theories are still appropriate.

Innovation in digital technology adoption is essential for economic growth. Acceptance and familiarity with complex innovations are important factors to take into consideration when

taking it to scale (FAO et al., 2020). User resistance, a phenomenon that reflects the politics of personal boundaries to new digital technology has long been a central concern. This arises when individuals must engage in new digital technologies that pose disruptive and undesired changes to personal boundaries (Ramiller, 2013). A study in Tanzania to establish digital technology adoption patterns revealed that when not using participatory approaches, many digital technology solutions are not adopted. The study showed that involving users in the planning and design of digital platforms significantly impacts the effective adoption of digital technology (Barakabitze et al., 2017).
The study supports Principles for Digital Development (PDD) established in 2021 for ethical standards in D4D research.

- Governance models for research methodologies in development settings.
- Research in low-income areas often faces economic, political and social linkages, as well as power inequalities.
- External researchers dominate research activities, formulate agendas and collect data from developing countries, leading to a "brain drain" of outstanding academics.
- D4D ethics face ethical challenges with digital technology expansion (PDD, 2021).

Addressing these ethical governance challenges can lead to advantageous digital incorporation. This occurs when underlying structural inequities are addressed through digital interventions where discussions are taken into the realm of social justice, away from technology and design. The focus is on procedural digital justice and away from practices and procedures (Heeks, 2020). So, the next section explores the obstacles that some nations' small-scale farmers face when trying to employ digital technology. This can assist us to deliver advantageous digital incorporation and impact wider institutions, structural relations, digital rights and systems to deliver digital justice to small-scale farmers.

2.2.6 Obstacles to small-scale farmers' adoption of digital technologies

A significant issue is that small-scale farmers use technology at low capacities and that rural areas lack adequate digital technology infrastructure (Munyua, 2007). Other significant obstacles are researchers' inadequate digital technology skills and farmers' lack of digital infrastructure for sharing agricultural knowledge (Musa et al., 2013).

Small-scale farmers in Sudan's Gezira State faced several obstacles when attempting to use digital technology that include poor income, low education levels, cultural inertia and a dearth of pertinent localised material in regional languages. The same significant obstacles for small-scale farmers in Nigeria using digital technology to secure marketing information were recognised by Nmadu et al. (2013) as language, poverty and illiteracy. According to a survey of small-scale farmers in Kenya, their lack of infrastructure, poor literacy rates, unsuitable information services and technical skills prevent them from receiving relevant information (Odini, 2014). In a report presented at a conference held by the International Fund for Agricultural Development (IFAD), Samii (2008) said that the lack of access to pertinent data and digital technology infrastructure by developing countries was a major problem.

According to research, farmers' views on utilising new innovations change as technology does. Studies carried out in the United States of America in 2011 and 2007 indicated that farmers did not apply profitable farming technology because of high costs, time constraints and satisfaction with the status quo. These results showed the importance of education in fostering adoption despite the possibility that they could have been distorted by their unfamiliarity (Gillespie et al., 2007; Paudel et al., 2011). A comparable survey conducted in 2020 found that profit was the most significant factor, followed by environmental advantages. Additionally, research showed that older farmers were more prone to adopt technologies for profit-related reasons than younger farmers who were more likely to consider environmental factors (Paudel et al., 2020).

The research mentioned above revealed several impediments to small-scale agriculture's use of digital technology that are outside the farmers' control. Given their modest wages, small-scale farmers typically find it challenging, if not impossible, to purchase digital technology on their own. This consequently restricts the use of digital technology for its economic sustainability and productivity. This implies that for digital technology to be successfully employed in small-scale agriculture, cooperation from the government and other agricultural sector development institutions is required.

Digital technology tools that can effectively address the problems encountered by the world's most disadvantaged farmers to make them more sustainable are driving modern agriculture more and more (Sein et al., 2019). Although D4D is effective to link smallholder farmers, it can create path dependency which can lead to adverse incorporation among actors (Heeks, 2020). The poor are increasingly using D4D to improve their capacity (capabilities) to perform more functions. The findings of this study support Heeks' (2016) assertion that D4D has an impact on economic, livelihood or competence development and that it is critical to comprehend the political, social and economic dynamics that affect the socio-technical systems of D4D. Therefore, it is necessary to pinpoint the social, political and economic aspects that have an impact on small-scale farmers' capacities to improve their ability to use digital technology as a development tool in their processes and plans.

It is important to understand how D4D can address the challenges of the digital divide in small-scale agriculture. This will inform the need for policies and regulatory frameworks to address the risks so that digital technology can contribute towards all dimensions of sustainable development (FAO, 2020). This study uses Theoretical frameworks that operationalise the Capabilities Approach (CA) and Sustainable Livelihoods Framework (SLF) while implementing technology because it is interested in examining the factors that affect small-scale farmers' capacities to boost their functioning. Thus, the next section discusses the theoretical lens used for this study to examine D4D in AVCs of small-scale farmers.

2.3 Theoretical premises of D4D in AVCs of small-scale farmers

This section discusses the theoretical underpinnings used for the study. The theoretical frameworks to understand how digital technology adoption leads to the development of AVCs for small-scale farmers are explored. This research tried to uncover theories that link digital technology adoption to development to help guide practice and inform research.

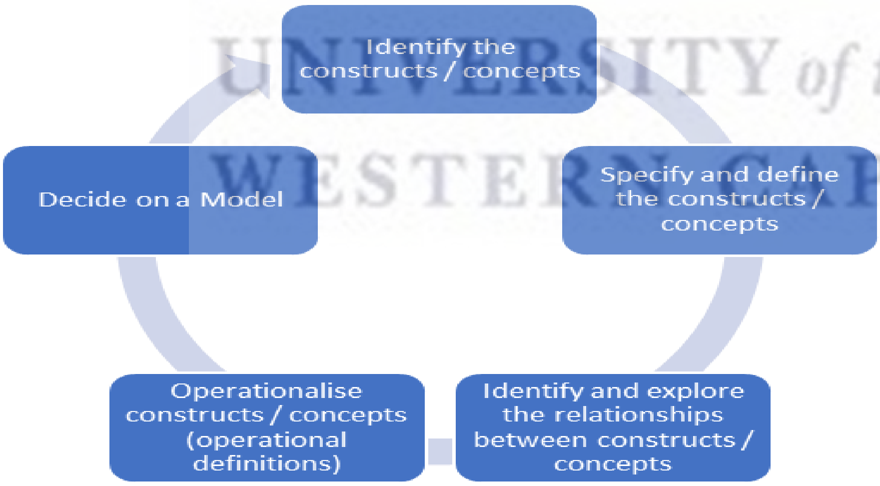


Figure 2-3: Steps followed to investigate different Theories. (Source: Adapted form Nilsen, 2015; Vinz, 2022)

Creswell and Plano Clark (2011) argue that the theoretical perspective influences and determines the kind of theory to be applied to the research. The theory offers a framework for the research's data-gathering stage as well. Whilst worldviews function from a broad perspective, theoretical foundations operate from a restricted perspective when used as a lens (stance) by the researcher to guide various research phases (Creswell & Plano Clark, 2011). The following steps in Figure 2-3 were followed when different theories were investigated to propose an initial theoretical framework to do the literature review:

- Identified the constructs/concepts.
- Specified and defined the constructs/concepts.
- Identified and explored the relationships between constructs/concepts.
- Operationalised constructs/concepts (operational definitions).
- Decided on a Model.

Digital interventions can significantly contribute to human development, and the Capabilities Approach (CA) can offer some theoretical reflections and a lens to help avoid the traps of an economy-only perspective (Zheng, 2007). A rethinking is needed to comprehend and approach technology development for precarious agricultural livelihoods due to the complicated mix of constraints that come with technology adoption (Ospina et al., 2016).

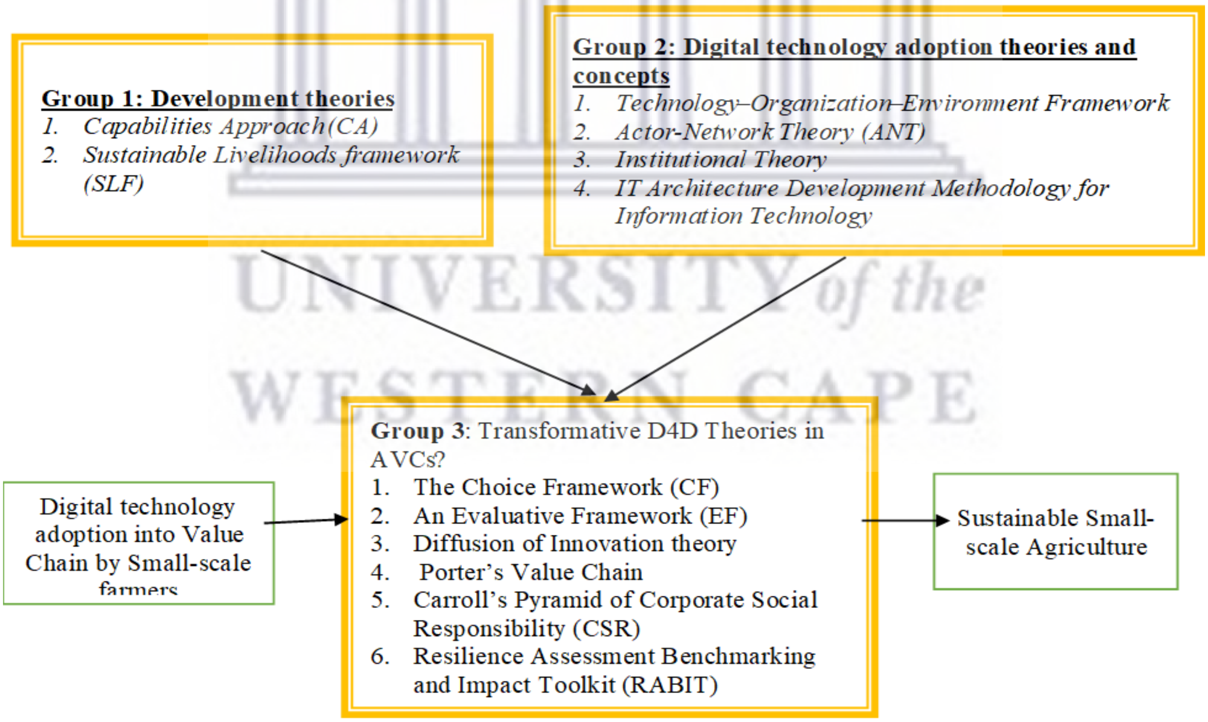


Figure 2-4: Theoretical underpinnings of D4D for this study. (Source: Adapted from Maung et al., 2019)

This study suggests a comprehensive grasp of the theoretical underpinnings of D4D for small-scale farmers, thus it was necessary to have a good awareness of three categories of theories. The three categories are born out of the three concepts which make up the definition of the field of "Digital for Development" (D4D): "Digital," "Development," and "4" or "for" concept that is referred to as a "transformative process". In particular, the three theory groupings are depicted in Figure 2-4 as the following: Development theories (What is development?), digital technology adoption theories (What is digital technology adoption?) and theories of transformative processes that connect the adoption of digital technology to development (How is the adoption of digital technology a catalyst for development?).

To minimise duplication and address the concepts and concerns surrounding the topic, it is crucial to review the literature within the current body of theoretical knowledge. To begin to do this, it is important to theorise D4D and give context to digital platforms and the New Digital Economy. This will clarify the implications of digital technology adoption AVCs of small-scale farmers and the governance requirements for developing inclusive digital innovation platforms (Maung et al., 2019).

Thus, the next development theories, the theories conceptualising digital technology adoption and theories on the transformative processes linking digital technologies to development, D4D and to AVCs are discussed in more detail. In the end, this study integrates some of these concepts and constructs a theoretical framework that underpinned this research.

2.4 Theories on development

To explore the relationships between the adoption of digital technology and the growth of small-scale farmers, the study reviews important components of the Capabilities Approach (CA) and the Sustainable Livelihoods Framework (SLF). Firstly, a thorough analysis of the CA in terms of its concepts and constructs is presented, using Sen's concerns and critiques of utilitarianism and resourcism. The concepts of functionings and capability are defined, describing the freedom of choice and valuation which are central to human capabilities in having people live the life they choose to live. The discussion of the CA ends with looking at how the CA can be applied to Digital for Development Projects (D4D).

Secondly, the SLF discussion starts with an overview, introducing the vulnerability context that suggests that all livelihoods get acted upon by many different processes and programmes that constantly change. This study supports the argument that people-centred analysis is crucial to achieving the right livelihood outcomes or functionings, by first considering the assets and objectives of small-scale farmers. The different relationships of assets needed to create certain capability sets to develop certain livelihood strategies to become sustainable farmers are discussed. The objectives achieved here are like the functionings of the CA.

The theories on development section concludes with a discussion of how the CA and SLF can help us develop a framework to adopt digital technologies in AVCs of small-scale farmers. The study identifies the shortcomings where the CA and SLF have been applied, and this forms the basis of using the CA in conjunction with the SLF when analysing or implementing the theoretical context of D4D for small-scale farmers in AVCs.

Farmers relate differently to sustainability as they are affected by different situations in different ways. Thus, sustainability as a concept is defined by varying scholars differently. For this study, sustainability is defined as the situation where small-scale farmers can gather enough resources that give them the means to acquire the necessities to recreate themselves (Asenso-Okyere et al., 1993). The plans and techniques implemented to make small-scale farmers sustainable are known as development. A farmer’s sustainability is used to assess how developed the farmer is (Smith, 1986). To develop small-scale farmers, it is vital to perform a situational analysis that establishes how they are excluded economically, marginalised socially, exploited in a class framework and disempowered politically (Bene, 2003).

Being unsustainable can also refer to a small-scale farmer's inability to participate in certain AVCs. Small-scale farmers do not have enough flexibility to live the life they want to live since they are unable to function with their diminished capability. Hence, if small-scale farmers are developing, their actual freedoms are being expanded. This involves the freedom to pursue what is essential to them, their choices and their objectives (Sen, 1999). Thus, although sustainability can be described in several ways, it always involves a small-scale farmer being active within AVCs. The importance of how the small-scale farmer relates to sustainability can be described by the CA discussed next.

2.4.1 Capabilities Approach (CA)

The CA was motivated by Aristotle's study of political distribution with respect to decent people and how it is connected to man's function in life when he articulated the CA. Despite thinking this to be ambitious, he was very interested in the idea of the important things in life and how they may be accomplished for a good quality of life (Sen, 1985). In this study, the CA was used to help researchers better understand the choices people make to support their functionings.

The CA was first introduced in the 1980s, indicating new approaches for assessing human well-being beyond only considering resources and utilities (Wells, 2012). He was influenced by Karl Marx's ideas, as well as Adam Smith's strategies and stressed the significance of developing the capabilities to perform at a certain level for development to happen (Sen, 1985). Sen (1985) emphasised the necessity for small-scale farmers to have the freedom and agency to live the lives they want. Small-scale farmers' skills should be utilised to establish specific functionings that give small-scale farmers effective freedom for a foundation of justice based on social choice and culture. The capabilities of small-scale farmers should be the main subject of evaluation. Small-scale farmers have the option to carry out certain functions in terms of how and what they wish to accomplish thanks to effective freedom (Wells, 2012).

Sen (1985) opposes using utilitarian traditional measures like the standard of living by assessing valuable items based on resource valuation and utility. He emphasises the importance of applicability, relevance and freedom in analysing and helping the poor, as these factors are complex and closely related to a person's capability set.

Through well-being and agency, small-scale farmers can achieve freedom and the foundation of justice. Individual freedom involves human rights and culture as a social commitment, which are fulfilled through social choice and individual behaviour. The relationship between rights and freedoms may be obstructed by cultural norms and attitudes, leading to economic deprivation (Knopf, 1999).

Small-scale farmers may have the same resources, but it does not guarantee they will produce the same crops, as they may differ in their ability to operate for a variety of reasons (Sen, 1985). The CA contributed significantly to the theory of social justice when he argued that capabilities should be the space through which people should be assessed and compared. Capabilities in the tradition of social contract assist in establishing some Human Rights (Nussbaum, 1998). It is extremely difficult to attain justice in terms of means and freedom when taking various goals and approaches into account. Justice refers to the fairness of applying individual traits and traits in combination with the many aims that different people have for their lives (Sen, 1990). According to research, digital technology improves small-scale farmers' capabilities and livelihoods, which fosters economic growth and reduces poverty (Mago and Mago, 2015).

In terms of inequality and poverty, the CA can be used to assess the well-being of particular people or groups of people. Assessment begins at the person level, where it considers social structures and overall well-being. It can be used as a normative framework for the development of policies to end poverty and for the evaluation of those policies (Robeyns, 2005). This study supports the above arguments that also consider culture when looking at analysing and implementing Digital for Development (D4D) projects. It takes into consideration Sen’s concern about the right of individuals to make personal choices. This has a combination of characteristics to obtain divergent objectives to create true justice. As a result, people should decide how they should be evaluated, allowing them to select the lives they are content to live.

The justifications given above demonstrate how small-scale farmers in developing nations can use digital technologies to improve their abilities to carry out specific functions. This study explores how small-scale farmers' use of digital technology as a development tool might improve their processes and tactics. This has a clear connection to the SDG for eradicating poverty, which is likely the most significant SDG overall. The study also evaluates the CA's core ideas and investigates applying digital technologies and small-scale agriculture to end poverty. The next section discusses the meanings of functionings, capabilities, individual agency and conversion factors.

2.4.1.1 Functionings, Capabilities, Individual Agency and Conversion Factors

Functionings are the daily tasks people perform to keep healthy and rejuvenated. The structural opportunities that a person has or can create are related to their "capability" (ability to carry out desired functions). One can take physical resources and transform them into something useful by using the conversion factors that allow one to convert a resource (Alkire, 2005). One of the capabilities that is thought to be possessed by someone is the capacity to convert resources into functionings (Sen, 1999).

According to the CA, growth entails having the freedom to live the life you want. The foundation of the CA is individual agency. The interconnectedness of human development with sociocultural context emphasises how social institutions affect personal agency (Zheng, 2007). Sen (1985) makes the case for the usage of agency freedom and well-being freedom, such as people's capabilities (opportunity), combined with their capacities (agency) to attain specific functionings. Development, according to the CA, is the ability to live the life one chooses without no constraints (Zheng, 2007). Capabilities and choice freedom can both be expanded by digital technology adoption and education, which can then promote economic freedom and personal income freedom (Sen, 1999).

Conversion factors refer to the extraction of functions from a resource, categorised into personal, societal and environmental factors. Personal factors involve private aspects, while social factors involve society and interactions. Environmental factors involve the constructed environment (Robeyns, 2005). Disparities in performance can arise from various factors, including physical or mental conditions, changes in non-personal resources and reactions to environmental changes like climate, epidemic risks or local criminality. People with equal means may not always produce equally (Sen, 1985).

Small-scale farmers' ability to convert resources depends on their social and environmental context, available resources and structural options. To succeed, they need a broad range of capabilities, opportunities and freedom to convert resources into useful products (Sen, 1999). Understanding fundamental human capacities regarding "choice" and "value," which are explored next, is crucial.

2.4.1.2 Central Human Capabilities: Overview of Choice and Valuation

The capability set is a representation of the various lives that people can lead by making use of their resources and tools to achieve various objectives. In order to pursue different functionings, the individual has a right to alternative means and freedom in capability selection (Sen, 1989). Education can improve capacity and decision-making flexibility, which can foster financial independence and the freedom to spend one's resources (Knopf, 1999). Nussbaum (2000) improved the CA by defining gender and social justice as fundamental human needs. The policy promotes small group attention, using aggregate data for measuring capabilities.

The CA advocates for the state to oversee meeting social demands such as those related to education, healthcare and other things (Knopf, 1999). Education increases a person's ability and aids in converting resources and means into capabilities that can achieve certain functionings (Nussbaum, 2000).

Human rights and capabilities differ significantly, but they both contribute to growth conditions. Everyone has the right to protect their rights, regardless of their location or state recognition. Opportunities are feasible, and people can choose to take advantage of them (Sen, 2005; Nussbaum, 2000).

The relationship between rights and freedom of choice can be complicated by certain cultural norms and attitudes. An individual's freedom is fulfilled through social choice and personal behaviour as a social commitment (Knopf, 1999). To develop individual features and blend them with the varying objectives of other people to achieve their various life goals, justice must be implemented fairly. Because people have different life goals, it might be challenging to achieve justice in terms of resources and freedom (Sen, 1989).

Choice and Value contrasts clean water with iPad purchase, illustrating priorities in functions. Aggregation emphasises group over individual in policymaking, with choices valid only when everyone is involved. Acquiring skills occasionally is related to agency (Nussbaum, 1997). CA applications must consider these factors when evaluating or implementing development programmes for small-scale farmers. This is discussed in the next section.

2.4.1.3 Application of the Capabilities Approach (CA)

Since 1990, the UNDP has incorporated fundamental knowledge into its annual reports on human development, comparing countries like China, Sri Lanka, India, Brazil and Mexico. The study found that Brazil and Mexico have higher GNP per capita than India, China and Sri Lanka. Sri Lanka performed better in life expectancy, new-born mortality and child mortality rates, defying economic assessments (Haq, 1995).

Alkire developed a capability analysis using cost-benefit evaluations for three Pakistani small-scale development initiatives: farming, education and horticultural output, comparing their effects on capability (Alkire, 2002).

Numerous studies investigated the demographic makeup of the poor in advanced economies to assess poverty and well-being. The study examined a sample of poor individuals to determine whether they were income-poor, functioning-poor (a lack of education, nutrition or health) or both (Alessandro Balestrino, 1996).

2.4.1.4 Critiques of the Capabilities Approach (CA)

Critics argue that the CA's vagueness raises uncertainty, as it requires considering all opportunities and capabilities. Assessing functionality's feasibility is crucial, and timing and assessment timing are important for different functionings (Gasper, 2007).

Since the CA has many dimensions and could be difficult to operationalise, many detractors question its viability. Despite having some excellent principles and features, this can lessen the impact of the approach (Comim, 2001). Do certain abilities need to be developed before others start to cause uncertainty when choosing weighing, evaluation and what is important? The method's operation can sometimes be carried out in a wide range of ways, but it can also occasionally be refined to the point where potential prospects can no longer access it (Gasper, 2007).

The CA can assess or consider a community's or an individual's level of well-being. It can be used to examine and create programmes to end poverty or inequality that begin with an examination of an individual level (Robeyns, 2005). According to the CA, functionings are the daily tasks that small-scale farmers must accomplish in order to exist, as well as the processes by which a single farmer can transform physical resources into a functioning. Therefore, a farmer's capabilities are the opportunities they have or can grow to reach desired functionings (Alkire, 2005). Questions about the CA's suitability for directing the collection and interpretation of empirical data come up through the critical engagement of Sen's CA. Collective capital is derived from social capital, and the CA places an excessive focus on individual choice (Stewart & Deneulin, 2002). Using digital technology, where newly communal skills are developed through collective action, communities' social capital can increase (Andersson et al., 2012). The study provides the social, political and economic elements that affect small-scale farmers' use of digital technology in AVCs, as well as the ramifications for institutions and governance. The CA emphasises prioritising vulnerable small-scale farmers' decision-making and function in agriculture value chains using CA to understand political, social and economic factors The Capabilities Approach faces criticism for potentially limiting others' rights due to freedom of choice. Critics argue that expanding the scope or emphasising a wide range of abilities may question its effectiveness. The Sustainable Livelihoods Framework discussed in the next section might be able to address these issues.

In conclusion, Sen's objections to assessing the elimination of poverty and inequality in terms of utilities or resources led to the conceptualisation of the CA. He underlined that everyone has the right to live the life they choose, and he outlined a strategy that put a strong emphasis on it. Concepts like functionings, capabilities, individual agency and conversion factors were introduced by him. To translate talents and opportunities into functionings that give people effective freedom, well-being freedom and agency freedom are used. Social practices may limit people's skill sets or favour the skills of one group at the expense of another. Theoretical and conceptual thinking that highlights the collective and society can be added to the CA to enhance it. Everyone has their personal capacity for freedom, which is determined by their environment and social environment, the resources they have access to and the freedoms they must convert to opportunities (structural opportunity). The next section discusses applying the CA when doing Digital for Development Projects (D4D).

2.4.1.5 Applying the Capabilities Approach (CA) in Digital for Development Projects (D4D)

There is a lack of knowledge on applying the Capabilities Approach (CA) in Digital for Development Projects (D4D) projects (Tshivhase et al., 2016). Scholarly attention is growing on integrating technology within the CA framework, with digital technology being viewed as a unique capability input. The theoretical development should include digital technology, which has both generative and transformative dimensions, creating a new class of conversion factors (Haenssgen & Ariana, 2018).

Coherent digital transformation strategies for whole-of-government and whole-nation approaches are crucial for a digital economy, ensuring small-scale farmers are digitally mature and aligned with institutional structures and capabilities (Melhem & Jacobsen, 2020). Introduced in the CA, technical objects and technological conversion factors can be introduced as additional elements, focusing on inputs, socio-technological environment and conversion factors in generating valued capabilities. This theoretical justification enhances the CA analysis and can help develop research questions on technology's social implications (Haenssgen & Ariana, 2018).

To promote digital transformation, it is crucial to investigate the digital capabilities of leadership, skills and culture. This should complement technological expenditures with digital capabilities programmes, funding the "soft" infrastructure. Digital culture is essential for maintaining digital transformation initiatives (Melhem & Jacobsen, 2020). This study focuses on supporting small-scale farmers' digital transformation through strong leadership, improving digital literacy and promoting a digital culture. It aims to bridge the digital knowledge gap and redesign government services, focusing on farmer co-creation and addressing the digital skills gap. The SLF is now presented and investigated in how it can be used in conjunction with the CA as the development theoretical component of the framework.

2.4.2 *The Sustainable Livelihoods Framework (SLF)*

The Department for International Development (DFID) revised the outdated Chambers and Conway (1992) definition of a livelihood in 1999. A livelihood, in the eyes of DFID, consists of the abilities, assets and pursuits required for a livelihood. An existence is sustainable if it can withstand stresses and shocks, recover from them and maintain or increase its capacities and resources in the present and the future without compromising the base of available natural resources. This must lead to immediate, long-term advantages for livelihoods at the local and global levels (Serrat, 2010).

Table 2-1: The main elements of the Sustainable Livelihoods Framework

Holistic view:	Identifying major obstacles and understanding stakeholder livelihood complexity.
Dynamic:	People's livelihoods and the institutions that oversee their lives are extremely dynamic. The strategy learns from changes and helps reduce negative effects while encouraging good benefits.
Building on strengths:	Dynamic livelihoods require adapting strategies to reduce negative effects and promote benefits.
Macro-micro links:	Emphasise development focusing on macro- and micro-level relationships to reduce distance and achieve sustainable development at the micro-level.
Sustainability:	Sustainable livelihoods can withstand external shocks, be independent, support long-term resource production and avoid risking others' livelihoods.

(Source: Kollmair et al., 2002)

A framework is a "particular way of looking at the world," and the Sustainable Livelihoods Framework (SLF) takes the perspective that households achieve sustenance by making use of their resources and capacities to develop livelihood strategies that incorporate a range of activities (Serrat, 2010). Its emphasis on people's talents and abilities rather than their requirements is one of the SLF approach's core qualities. It always relies on sustainability and considers macro- and micro-level policies when affecting people's livelihoods through activities (Scoones,1998).

The participatory nature, assumption of differentiation and thoroughness of analysis are the guiding principles of the livelihoods approach. Reflective practice improves the effectiveness of analysis and intervention, resulting in individualised treatments that have the maximum impact (Serrat, 2010). The framework becomes a living instrument for development when concepts are brought to life. The individuals you want to grow must be included in the study, as well as the development of strategies and procedures (Ashley & Carney, 1999).

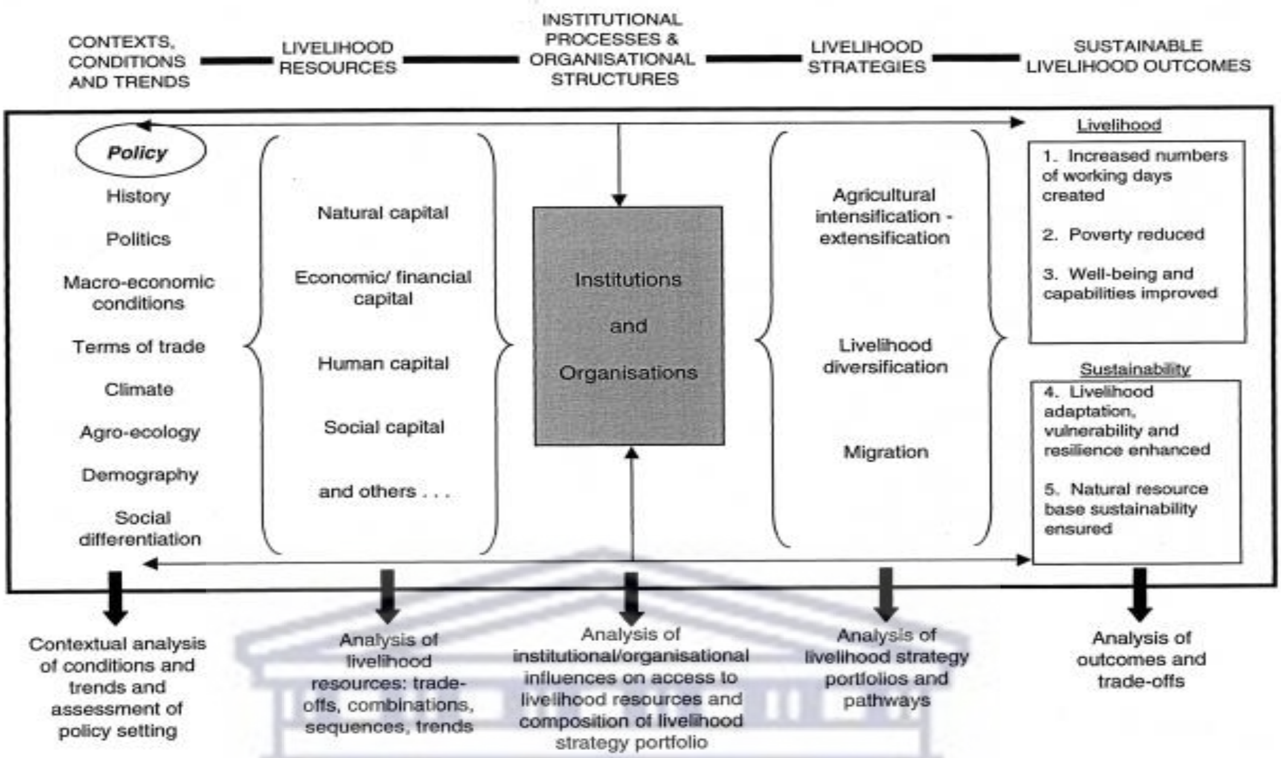


Figure 2-5: Sustainable Rural livelihoods: A framework for analysis. (Source: Scoones, 1998)

Opportunities and limitations influencing livelihoods are noted wherever they exist. The SLF shown in Figure 2-5 connects micro-focused, participation-required, macro-micro and multilayer strategies that concentrate on the participants. The macro-level factors, such as national and international policy, have an impact on the region's livelihoods (Scoones,1998). According to the SLF, stakeholders operate in a precarious climate with some resources at their disposal. The weight and value of assets are influenced by the current social, institutional and organisational context (policies, institutions, and processes). This environment has a substantial impact on the livelihood possibilities available to people as they pursue their individually defined excellent livelihood outcomes (Kollmair et al., 2002).

By dialogue with partners, the SLF focuses on the underlying social, political and economic factors that underlie underdevelopment. The concept identifies gatekeepers who may use corruptive tactics to influence processes for their profit (Ashley & Carney, 1999). Thus, according to Carney (2002), the DFID objectives for sustainable rural livelihoods include the following: protecting the use of natural resources; improving access to financial resources; improving access to education; improving access to information; improving access to technologies; improving access to training; and improving access to facilitating infrastructure as well as policy and institutional environments that support a variety of livelihood strategies that encourage equitable distribution of resources.

2.4.2.1 The Vulnerability Context

People's assets must be investigated before placing them at the centre of our study, thus it is crucial to establish the goals they are trying to accomplish with these resources and identify the livelihood tactics or functions they will need to use to succeed (DFID, 1999). The focus is on expanding access to these resources to support livelihoods. Small-scale farmers use the resources they either own or have the legal right to use to help them establish sustainable means of subsistence (Carney, 1998).

The SLF attempts to describe how people act within a context of vulnerability that is influenced by a variety of factors, such as fluctuating seasonal restrictions (and possibilities), economic shocks and longer-term patterns. According to this vulnerability context, they use their asset base to create a variety of livelihood strategies to accomplish their desired lifestyle outcomes. This is all influenced by how people use various capitals or assets for their means of subsistence in diverse combinations (de Stagé et al., 2002).

As a result, before certain livelihood outcomes can be achieved, a livelihood analysis of the context of their vulnerability must be done. This may alter as a result of a wide variety of factors and reasons that are always shifting. The vulnerability context offers a thorough assessment of the potential effects of a variety of key trends, shocks and seasonality on people's livelihoods and the availability of assets. It defines the outside world in which people have limited or no control over what might occur and how their lives might be affected. Trends, shocks and seasonality can significantly affect how people's assets are doing and their capacity to live sustainably (DFID, 1999).

Shocks have the potential to destroy property rights away and force small-scale farmers to abandon their livelihoods as a coping mechanism. Trends affect economic return rates or preferred methods of sustenance and are easier to predict. Seasonal variations in prices, employment and opportunity are some of the biggest and longest-lasting sources of hardship for small-scale farmers in developing countries (DFID, 1999). There has been a significant paradigm change that makes it possible to focus on assets and strengths to promote small-scale farmers, even though many development practitioners still place their attention on needs or shortfalls. If these resources and strengths are properly applied, they can help meet some of the needs of small-scale farmers. Next, we will discuss the asset pentagon, one of several techniques the SLF employs to identify communal assets.

2.4.2.2 The Asset Pentagon

The Asset Pentagon becomes the focal point of the vulnerability context because of the continual change in people's assets and endowments. To better comprehend the means of subsistence used by the poor, the Sustainable Rural Livelihoods Advisory Committee developed this tool. They improved upon prior work by the Institute of Development Studies and other contributions (Carney, 1998). The pillars of livelihoods are the five primary asset categories of capital recognised by the SLF. These resources can be utilised to improve livelihoods and reduce poverty by increasing access through increased ownership or the right to use. People can build five different types of capital: human, natural, financial, physical and social. These resources serve as the foundation for livelihoods (Scoones,1998).

The asset pentagon, which was developed to visually display information about people's assets, is an important part of the framework. It highlights how important it is for diverse assets to interact with one another and how they may use in a variety of ways to create favourable livelihood outcomes. Two particularly important relationship types are how assets should be shared and where the emphasis should be on livelihood. This implies that to make up for a lack of an asset, it can be replaced by another (Carney, 1999).

2.4.2.2.1 Human Capital

Human capital is defined as the capacity to work, have the requisite knowledge, be in excellent bodily and mental health and pursue a variety of livelihood strategies and goals (Carney, 1998; Scoones, 1998). Thanks to human capital, small-scale farmers can use a variety of livelihood methods and achieve their livelihood objectives. To use any of the other four types of assets, acquiring human capital can be helpful and is required. For one's livelihood to benefit, it is insufficient on its own. Knowledge production and diffusion are intertwined with social capital. Strong levels of social capital can greatly boost levels of human capital (DFID, 1999).

2.4.2.2.2 Social Capital

Social capital involves networking and participation in social groups, affecting policies and practices. It facilitates information exchange and innovation and can be a valuable resource for small-scale farmers facing disasters (DFID, 1999). The SLF framework enhances individuals' living objectives by utilising social resources in institutionalised groups, fostering horizontal and vertical connections and enhancing cooperation and trust building (Carney, 1998; Scoones, 1998).

Small-scale farmers have access to social resources that enhance their capacity for collaboration, foster trust and help them achieve their objectives of maintaining their way of life. Social capital directly affects other types of capital by improving the effectiveness of economic linkages, and it can increase small farmers' profits and savings rates.

Social capital can be employed to create capacities for achieving particular functionings. The study makes the case that how to support people in a group setting is particularly important. It can guide our decisions on suitably effective group dynamics and the best ways to connect small-scale farmers. This will demonstrate the relationships between various governmental frameworks and ideologies and various types of social capital at the local level.

2.4.2.2.3 Natural capital

Natural capital refers to resource flows and services that originate from the environment and are required to produce income. Natural capital can be tangible, used in the production of agriculture, trees and land, to mention a few or it can be intangible, like the atmosphere and biodiversity (DFID, 1999). It is critical to consider how quality and accessibility are evolving for all forms of natural capital (Carney, 1998).

2.4.2.2.4 Physical Capital

Physical capital consists of the necessary producer products and fundamental infrastructure advancements to the physical environment required to support livelihoods. Producer goods are the machinery and tools that small farmers employ to boost output. It is normally important to have access to decent transportation, secure housing and buildings, enough water supply and sanitation, clean, affordable energy and information for sustainable livelihoods (DFID, 1999).

The public frequently makes use of infrastructure without being formally compensated. There are a few exceptions, such as housing, which is typically privately owned and some infrastructure that can be used for a price based on consumption (toll roads and energy supplies). Producer products can be accessed through rental or "pay for service" marketplaces, the latter of which is prevalent with more complex equipment, or they can be owned on an individual or group basis (Carney, 1998; Scoones, 1998).

To integrate the rural areas where many small-scale farmers live, infrastructure, such as telecommunications, railroads and roads, is crucial. The SLF is concentrated on providing small farmers with access to the required infrastructure so that they can achieve their livelihood aspirations. To determine user preferences, interactive approaches must be used (Ashley & Carney, 1999). To reach the majority of human capacities, some of the infrastructure required for sustainable living must also be in place.

2.4.2.2.5 Financial Capital

Financial resources significantly impact consumption and generate income, transforming structures and processes into money through financial capital (DFID, 1999). Financial capital refers to resources used for living, with two primary sources for businesses.

- **Available stocks**: Savings are preferred capital sources due to their absence of liabilities and reliance on others. They can be stored in cash, bank accounts, or liquid assets.
- **Regular financial inflows**: Trustworthy inflows from pensions, state transfers, and remittances contribute to financial capital (Carney, 1998; Scoones, 1998).

2.4.2.3 Transforming Structures and Processes

Changes to structures and procedures have a big impact on access to assets. It generates assets by making investments in the core infrastructure (generating physical capital), the advancement of technology (creating human capital) or the creation of regional institutions that bolster social capital. It also manages who has access to ownership rights, how shared resources are used and how quickly assets are accumulated (Carney, 1998; Scoones, 1998).

Structures and processes that are changing are sensitive to the impact of individuals and groups. The endowment of one's assets boosts their capacity for influencing others. Those with more resources are frequently thought to be able to choose from a wider array of livelihood options. Research on the causes and effects of poverty has shown that a person's potential to escape poverty and attain better living outcomes depends heavily on their access to assets.

2.4.2.4 Livelihood Strengths

The livelihoods analysis process faces challenges in implementing sustainability due to its complexity. Assets can be mixed in various ways, with sequencing focusing on asset order and substitution determining capital substitution for better outcomes (DFID, 1999). Organisational structures and processes significantly impact access to assets, but small-scale farmers' power may influence these changes. Those with more assets have more options and freedom, ensuring sustainable livelihood outcomes (Ashley & Carney, 1999).

This study argues that problems with the adoption of technology by small-scale farmers are typically brought on by unfavourable institutional arrangements and cannot be resolved by merely generating assets. To reform structures and procedures, the SLF looks at these assets holistically rather than sectorial. This includes defining livelihood possibilities in the context of vulnerability. The consequences depend on how structures and processes affect livelihoods. These are the small-scale farmers' decisions and sustainable practices. As the emphasis is on choosing the lives individuals wish to live, this promotes the CA. To create strategies to use the assets to address specific vulnerabilities, it also takes a more comprehensive approach to small-scale farmers' sustainability.

It seeks to understand shifting combinations of occupations in a dynamic, historical context. It specifically encourages friction between different analytical levels. It acknowledges the need to close the gaps between various sectors, including formal and informal, industrial and agricultural and urban and rural. It is inherently necessary to pay attention to both social relationships within the home and outside of it in order to examine the linkages between the numerous activities that make up a small-scale farmer's means of sustenance. The next section discusses applying the SLF when doing Digital for Development Projects (D4D).

2.4.2.5 Applying the Sustainable Livelihoods Framework (SLF) in Digital for Development Projects (D4D)

The livelihoods approach acknowledges digital technologies as part of a larger development picture, recognising their functional role in livelihood plans and analytical use to understand the poor's subsistence methods (Duncombe, 2006). Science, technology and innovation are crucial for agricultural expansion, improving energy access and livelihoods. Technology assessments are crucial for African nations to adapt and modify technologies for development goals. These evaluations help identify sustainable technical solutions, increasing resilience to future calamities. (UNCTAD, 2020).

Sustainable livelihoods require education, knowledge transmission and skills development in agriculture, agroforestry and resource management. Access to technology is crucial for smallholder farmers in Sub-Saharan Africa, enabling them to feed families and generate income (Onyango, 2016). The framework for sustainable livelihoods helps evaluate the impact of digital technologies on development, as their indirect effects can be challenging. By using this approach, it can expand its reach and be more analytically rigorous than other methodologies (Parkinson & Ramirez, 2006).

Limited natural resources and technology development without environmental considerations negatively impact human resources, talents, interests and priorities. The sustainable livelihoods approach addresses these issues and suggests adaptation tactics (UCL, 2020). Technology advancements like automation, renewable energy, robotics and AI can create environmentally responsible systems. This can enhance efficiency growth in manufacturing, transportation and energy generation while reducing waste and carbon emissions (UNCTAD, 2020).

Efficient uptake pathways for technology development are crucial for developing countries, as agriculture is a crucial economic sector. Improving production and market orientation can contribute to the sector's future viability and income for its dependent population (Onyango, 2016). A sustainable livelihoods technology strategy should enhance small-scale farmers' productivity, capabilities and opportunities, promoting equality and sustainability in social, economic and environmental aspects. It should provide control and establish connections between stakeholders (UCL, 2020).

This study uses the SL Framework to examine how technological innovations can develop small-scale farmers by strengthening social and political assets, and by creating efficient structures, digital technologies can provide greater benefits for the development of small-scale farmers. The SL approach emphasises connecting indigenous knowledge with external scientific information for problem identification and innovation. The SL approach promotes technological development and methodical efforts based on local scientific methods (UCL, 2020). Thus, SL technology solutions should be tailored to local small-scale farmers' social, environmental and climatological conditions, combining local and international technologies, prioritising local solutions and adapting to socio-economic and environmental changes.

Table 2-2: The strengths and weaknesses of the Development theories (What is development?)

	Capabilities Approach (CA)	The Sustainable Livelihoods Framework (SLF)
Key concept	CA expressed alternative ways of evaluating the well-being of people than simply looking at utilities and resources. The CA highlighted the importance of acquiring the capability to achieve a	A livelihood consists of the skills, possessions and pursuits necessary for a means of subsistence. A livelihood is sustainable if it can withstand shocks and pressures and recover from them in order to preserve or improve its capabilities and assets in the present and the future without compromising the natural resource base.

	particular level of functionings for development to occur (Sen, 1985).	
Dimensions	Capabilities are the structural opportunities to develop an ability of an individual to perform desired activities. Individual Agency (an individual's abilities, skills and choices) is the backbone of the CA.	Holistic perspective: participative and people centred. Dynamic: adapt to changes and minimise their effects while promoting favourable ones. Building on strengths: Recognise the potential to overcome limitations and uncover strengths that can increase robustness and help you accomplish your own goals. Sustainability: resistance to external stresses and shocks
Strengths	Assessment begins at the personal level, where it considers social structures and overall well-being. It can be used as a normative framework for the development of policies to end poverty and for the evaluation of those policies.	It strengthens analytical capacity and internal coherence. Increased comprehension, targeting and resource use. Development of specialised knowledge and focused abilities. It incorporates active approaches. Opportunities for collaborations and collaborations. It makes financing from donors more available. It enhances current strategies.
Weaknesses	CA is too vague, too ambitious, and far-reaching. Uncertainty arises to identify current and future alternatives. Timing of an evaluation of capabilities and whether functionings are probable to achieve. Usability of CA as it has a lot of dimensions. Its vagueness and its being too ambitious to make it operational.	The vulnerability context's components are far more significant than might initially appear to be the case. It is assumed that it is possible to increase people's gradually and generally "asset pentagons." Conflicts of interest and power imbalances are not appropriately recognised. The idea of "participation" could hide the truth that, in some way, improving one group's standard of living will impede that of another group. the insufficient definition of what constitutes a sustainable means of subsistence. What standards will be applied to evaluate sustainability over how long? Relationships with other parts of the framework are extremely intricate.

2.5 Theories on Digital Technology adoption

This section discusses concepts of theories on digital technology adoption integrated into the theoretical framework for this study such as Technological Organisation Environment (TOE) framework, Institutional Theory, Actor Network Actor-network Theory and ADMIT (Architecture Design [or Development] Methodology for Information Technology).

The TOE can show how digital technology adoption into the AVCs of small-scale farmers is affected by technological, organisational and environmental factors (Salazar & Holbrook 2008). The institutional theory explains how different institutions that need to be transformed or created affect digital technology adoption into the AVCs of small-scale farmers. Although Institutional Theory focused on stability, technology causes disruptive changes in society and institutions. Actor-network theory examines how digital technology adoption in AVCs of small-scale farmers is connected and related to different groups and institutions. Then, finally, ADMIT can be applied as a decision-making instrument for methodically creating a reliable architecture.

2.5.1 Technology–Organization–Environment Framework (TOE)

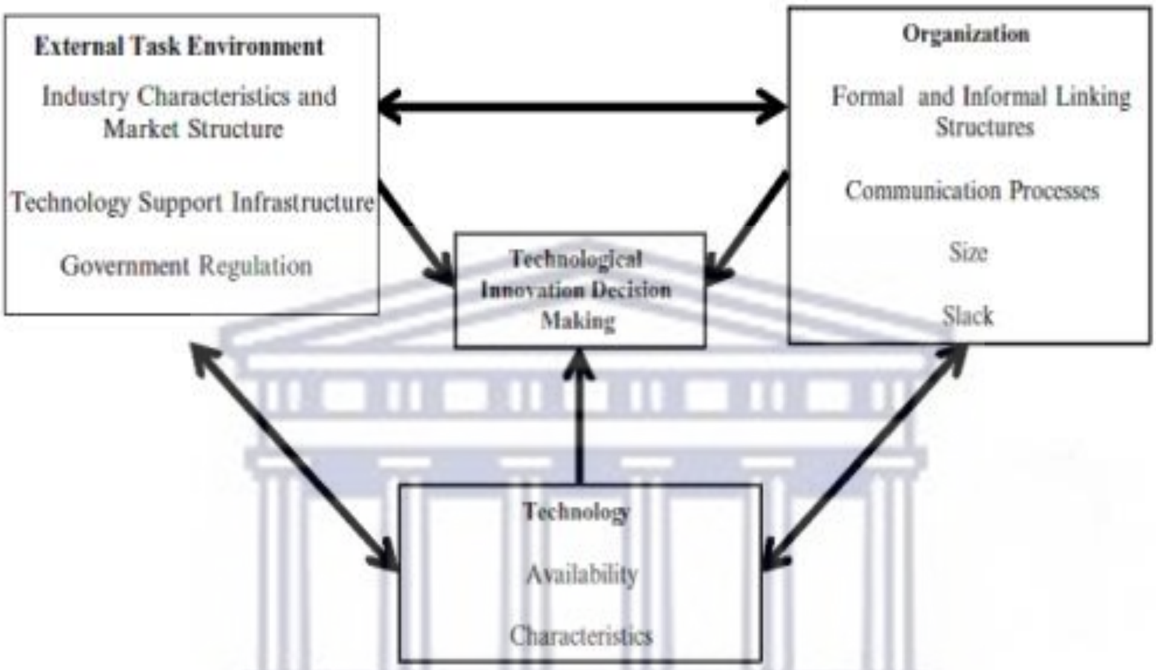


Figure 2-6: The Technology–Organization–Environment framework (Source: Baker, 2011)

The TOE model represented in Figure 2-6 has extensive applicability and explanatory value in a variety of technological, industrial and national/cultural contexts (Baker, 2011). Numerous studies conducted by the TOE have demonstrated that organisational, technological and environmental factors all have an impact on how quickly people adopt new technologies.
Our understanding of technical evolution and the primary variables influencing social change has been limited by the Science, Technology and Society (STS) debate on whether technology shapes society or society shapes technology (Salazar & Holbrook, 2008).

The TOE paradigm can continue to be utilised for an empirical study to understand the adoption of innovation in organisations, as well as for inter-organisational adoption as long as new technologies are developed (Baker, 2011).

2.5.2 Actor-Network Theory (ANT)

According to Bencherki (2017), an actor-network is a diverse group of people and things where, for one actor to act, several others must also act. Actors are treated equally and have equal potential agency (influence) over other entities within their networks (Carroll, 2016).

Individual or collective actors impact significantly on inter-organisational networks in areas of agency or in the ability to constitute organisations (Bencherki, 2017). The awareness of connectivity raises a profound sense of ambiguity regarding the borders and consistency of our social aggregates. This gives rise to the need for us to grasp electronic and digital social constructs (Lezaun, 2017).

By examining the links between people, groups and institutions, social network analysis can be used across disciplines to investigate how political players or institutions are related. It helps us to analyse how networks affect how individuals and groups, organisations or systems function since it places more emphasis on interaction than individual conduct (Elder-Vass, 2019).

2.5.3 Institutional Theory

An alternate investigation of the structures and layouts of organisations across all industries is made possible by institutional theory. Organisations are characterised as local manifestations of larger institutions that abide by structured rules in order to obtain legitimacy. This lessens uncertainty and makes an organisation's actions and activities more understandable (Berthod, 2016). To have a stable and permanent state, institutions must remain stable and change. This is true both when an established practice loses its legitimacy or ends all together and when it transitions from one institutionalisation to another (Sæbø, 2017).

Peters (2000) argues against explanations of institutions that are often static and against the challenges of categorising institutional variables into simple nominal categories. To better comprehend the dynamics and create more effective institutional justifications for social and political occurrences, he suggests that it should be a continuous variable.

The four criteria to assess a structure's institutionalisation are its autonomy, flexibility, complexity and coherence. This helps us comprehend the changes that structures must undergo in order to exist and exert influence over their constituents and surroundings (Peters, 2000). The problem is that institutional theory has typically focused on stability, whereas technology is frequently linked to quick and occasionally disruptive changes in society and organisations. There is a need to understand whether institutions impact technology or if technology influences them since the adoption of new technologies is influenced by societal factors. These events, which economic-rationalist models could not adequately explain, require our understanding (Sæbø, 2017).

2.5.4 IT Architecture Design Methodology for Information Technology (ADMIT)

ADMIT is a framework for making decisions that systematically develops a strong architecture utilising fifteen lifecycle process components and twenty design forces and strategies. This technique can be used in conjunction with other frameworks and describes an architecture development lifecycle, including its phases and management method. Based on the elements of enterprise, solution and system architectures, ADMIT comprises four information management domains and is used to build effective, adaptable and high-quality technological solutions. Architecture design forces (ADF) and Architecture development lifecycle are the two parts of ADMIT (ADLC). The strategies and methods for creating the architecture methodically are the main emphasis of ADFs. The phases and procedures for managing the development of the architecture are specified by ADLCs (Pradhan, 2013).

Any architecture is developed methodically under the direction of ADFs. They include Business Force, Operation Force, Future Force, Simplicity Force, Change Force, Process Force, Integration Force, Implementation/Pattern Force, Enterprise Force, Constraint/Environment Force, Failure Force, Channel Force, Content Force, Platform Force, Infrastructure Force, Network Force, Storage Force, Security Force and Cost Force. They also cover a wide range of issues. To successfully oversee the development of architecture, ADLC specifies fifteen processes.

Table 2-3: Processes, Phases & Areas in Architecture Development Lifecycle

Area	Phase	Process
Development	Planning/ Strategy	1. Identify business vision & strategy
		2. Plan stakeholder management
		3. Define architecture & technology strategy
		4. Assess current architecture
	Design/ Execution	5. Design target architecture
		6. Conduct gap analysis
		7. Develop execution roadmap

		8. Build reference architecture
	Management/Governance	9. Review architecture with stakeholders
		10. Perform implementation governance
		11. Manage lifecycle changes
		12. Manage architecture assets
Optimization	Optimisation	13. Improve architecture & process continuously
Automation	Automation	14. Automate lifecycle with tool &technology

(Source: Adapted from Pradhan, 2013)

According to the diagram above, these processes are divided into five phases: planning, design, management (from the development area), optimisation and automation (Pradhan, 2013). Based on organisational hierarchy and communication audience, the architectural activity's scope boundary and level of detail should be represented at the architecture level. By providing architectural oversight and direction, enterprise architecture synchronises technological strategies and execution plans with business ambitions and objectives. By addressing goals holistically across all IT initiatives, enterprise architecture also promotes consolidation, reuse and economy of scale. The IT systems, business procedures and reusable services for a business unit are defined by solution architecture which spans both business and technological architectures. In terms of multiple subsystem components and their connections to internal and external systems, system architecture describes the organisation of an information system. Software architecture is a subset of system architecture that focuses on application, data and technology.

Table 2-4: The strengths and weaknesses of Theories on Digital Technology adoption

	Technology–Organization–Environment Framework (TOE)	**Actor-Network Theory (ANT)**	**Institutional Theory**	**Architecture Development Methodology for Information Technology (ADMIT)**
Key concept	A study of technological determinism, or the idea that technology shapes society and that society shapes technical growth.	The idea of an actor-network is that it consists of numerous individuals and objects, whether or not they are human, and that for one entity to act, many others must also act.	An alternate investigation of the structures and layout of organisations across all industries is made possible by institutional theory.	ADMIT is a methodical decision-making tool for creating a strong architecture using the Architecture Development Lifecycle (ADLC) and Architecture Design Forces (ADF)
Dimensions	Explains that the factors that influence technology adoption decisions are the technological, organisational and environmental factors	Actors, Actor-Network, Symmetry, Translation Can make us understand how the constructs of electronic and digital proximity are "social.	Any observable organisation has four characteristics that can be used to gauge its institutionalisation level: autonomy, flexibility, complexity, and coherence.	ADLCS defines fifteen characteristics of the phases and methods of managing architecture development. ADFs are twenty design forces and strategies used to drive the systematic development of any architecture.
Strengths	A study of technological determinism, or the idea that technology shapes society and that society shapes technical growth.	A technique for analyzing connections between people, groups, or organisations is social network analysis. It emphasises conversation (rather than on individual behaviour).	gives compelling arguments for comprehending the changes that structures must undergo in order to live and be able to have an impact on their constituents and surroundings.	can be used as a roadmap for a thorough investigation to pinpoint the precise contribution of ICT use to particular development objectives.
Weaknesses	It does not cover everything or reflect the most recent research on the topic.	Decision making is continuously realised based on the ties between actors and the content that deal with the ambiguous and power-related issues.	Institutional explanations that are typically static and the persistent issue of quantifying institutional factors in ways other than simple, nominal categories	Model the intricate interactions between agency, structure, level of empowerment, and outcome, balancing the degree of theoretical development of each component. instead of measuring talents, this metric measures functionings. contrasts participatory assessment and monitoring procedures, which form the basis of people-centred development theory, with a focus on individual choices.

2.6 Transformative Theories that assist Digital for Development (D4D) in AVCs

For D4D programmes to assess or carry out efforts to reduce poverty, theoretical support is necessary. Understanding the advantages that digital technologies offer to people in developing countries is essential to foresee the consequences. Most contemporary technology development methods continue to be viewed via an evolutionary or modernist viewpoint. Given that economic growth is the most important development indicator, this is required (Andersson et al., 2012).

The study uses the CA to evaluate or consider the degree of well-being of individuals or groups (Robeyns, 2005). The CA can greatly improve human growth through D4D by putting forth some theoretical ideas. It enables considering several key challenges related to the development of digital technology. The CA can provide a lens to help us see beyond D4D's narrow concentration on digital technology in relation to the economy. The CA can identify the technological features used in D4D that present the pursuit of development as a freedom to pick up new talents that will enable individuals to live more fulfilling lives (Zheng, 2007).

This study uses additional frameworks in addition to Sen's CA and the SLF together as development theories together with digital technology adoption theories to complete the Theoretical framework for this study of using D4D in order to construct digital technology adoption in AVCs framework for small-scale farmers it also uses. These transformative theories include using the Choice Framework and incorporating elements of an Evaluative Framework, Diffusion of Innovation Theory, Porter's Value Chain, Carroll's Pyramid of Corporate Social Responsibility (CSR) and a Resilience Assessment Benchmarking and Impact Toolkit (RABIT).

To identify some of the gaps and solutions, the study must operationalise the CA and SLF. The next topic for discussion is the operationalisation of the CA and SLF while adopting digital technology in AVCs, which is addressed by both the CF developed by Kleine in 2010 and the EF developed by Hatakka and De' (2011).

2.6.1 The Choice Framework (CF)

Kleine (2010) introduced the Choice Framework (CF), which can be altered and reshaped, to help with analysis and project design for technological interventions. The CA presents a perspective on development that emphasises individual freedom rather than economic progress. The CF is operationalising this strategy by conceptualising the development process, and this conceptualisation can serve as a road map for a systemic and thorough study. Finding out exactly how the use of digital technology contributes to specific development goals has proven to be quite difficult (Kleine, 2010).

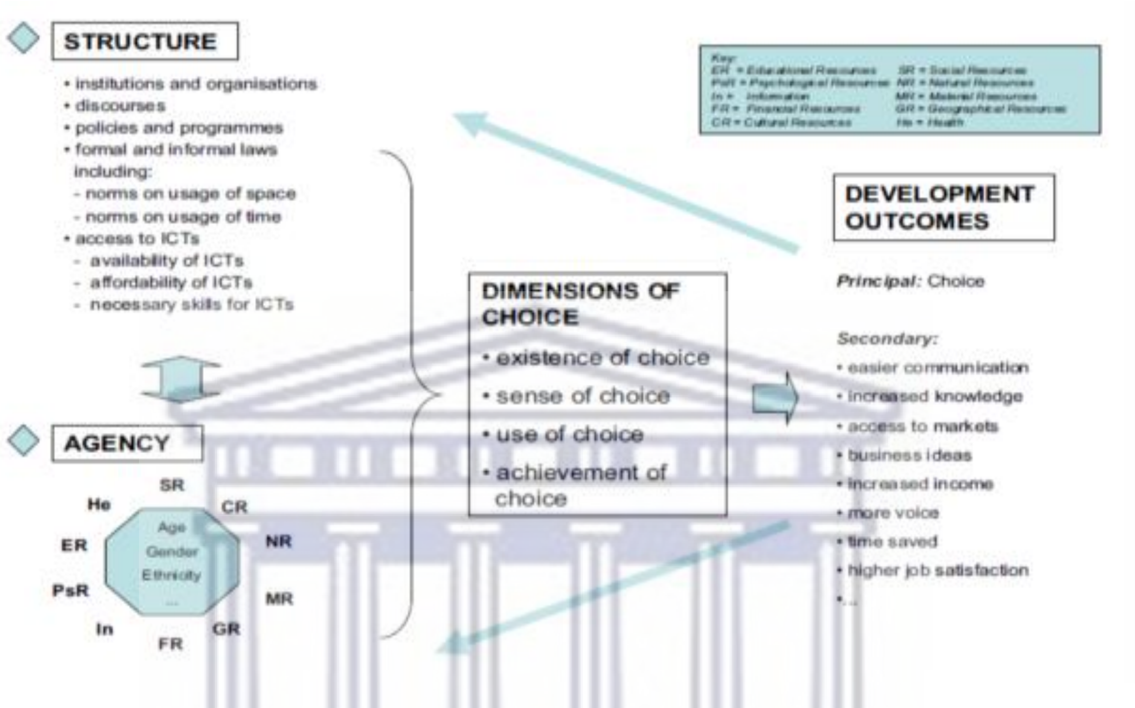


Figure 2-7: A schematic representation of the Choice Framework (Source: Kleine, 2010)

The framework distinguishes between different individual capability dimensions that link to a variety of outcome indicators that could be evaluated in relation to their potential digital impact (Gigler, 2004). The CF is used in this study to identify the factors that affect how small-scale farmers use digital technologies in AVCs. According to this paradigm, capabilities are the result of how assets interact, and by utilising specific structures and procedures, they can attain specific functionings like the SLF. These are the actual tactics used to accomplish livelihood goals.

Given that "digital poverty" has been identified as a brand-new aspect of poverty, there are numerous ways to gauge how closely connected these two phenomena are. The characteristics of the poor and the digital tools they employ are critical when examining the actual connections between digital technology and ideas of poverty. A few researchers have been able to demonstrate the micro-level impact relationship between digital technology and poverty throughout emerging countries (May & Diga, 2015).

Instead of attempting to understand D4D consequences within a linear economic view of development, Kleine's conceptual framework (CF) depicted in Figure 2-7 analyses D4D in a systemic and holistic approach. The CF tries to convert the CA and SLF into a D4D tool for systemic analysis. It has proven to be quite challenging to pinpoint the precise contribution that digital technologies provide to particular development goals (Kleine, 2010).

This study used Dorothea Kleine's (2010) CF to conduct a thorough analysis of the social, political and economic aspects that affect small-scale farmers' use of digital technology in AVCs since it was interested in learning more about the influences on this topic.

Kleine (2010) characterises the primary development outcome as the decision people make to accomplish this functioning and refers to the outcomes as achieved functioning rather than capabilities. Structure, agency, dimensions of choice and development outcomes are the four components that Kleine's CF emphasises. She also provides extra advantages like enhanced communication, increased knowledge, market access, business ideas, increased revenue, more voice, time savings and a happier workplace.

When using the CF, Figure 2-7 illustrates the systemic and ubiquitous effects of digital technology adoption on development. The systemic interrelatedness and co-causality of the effects are established after they have been aggregated. Structure and agency are at one end of the framework. Institutions and organisations, discourses, policies and programmes and formal and unofficial regulations, as well as access to digital technology, make up structure. Access to digital technology comprises having it available, finding it affordable and having the knowledge to use it. Resources of all kinds, including those for education, psychology, information, finance, culture, social, natural, material, health and geography, make up the agency. Gender and race are viewed as personal traits or personal conversion elements in the CF.

The structure that already exists may affect people's decisions and the results when small-scale farmers adopt digital technology into AVCs. The results may improve an individual's agency, which may result in improved structure usage. Interactions between structure and agency can result in decisions, and those decisions can influence how development proceeds.

A community of researchers studying D4D is particularly interested in the CF because it provides a method to operationalise Sen's capabilities approach. Digital technologies have the immense potential to give small-scale farmers more options (Kleine, 2010). For development outcomes to be realised, several conditions must be met: firstly, a choice must be possible; secondly, people must be aware that a choice is available; thirdly, people must exercise their right to do so; and fourthly, a choice-related consequence must be realised. To identify how specific results were accomplished, analyses of D4D initiatives based on the CF proceed backwards from outcomes to structure and resources.

The CF can only be used in certain circumstances, and more theoretical investigation is needed. Its primary objective is to represent the intricate connections between agency, structure, level of empowerment and consequence. The level of each element's theorisation is traded off. Secondly, while it is straightforward to use in qualitative work at the micro-level of the individual, applying it to communities, countries or even large groups of people can be difficult. Thirdly, it implies that individual choices have an impact on the systemic, pervasive and cross-cutting effects of digital technologies. Even though certain funders are open to participatory assessment and monitoring methods that form the cornerstone of the people-centred development philosophy, most donors have predetermined and easily quantifiable impacts (Kleine, 2010).

To evaluate the effects of digital technology on well-being, an analytical framework based on the three stages of hierarchical digital achievements, namely access, usage and appropriation, is required. In terms of the results of digital technology, this should also include one more level of the digital divide. Digital technology assets like access, usage and appropriation are incorporated as independent variables to improve the research of digital technology's impact on a far wider and more varied range of issues (Dodel, 2015). A group should be targeted through participatory project design, monitoring and evaluation since these individuals are enabled to choose the lives they value. A practical way to combine individual strengths to enable group decision-making is through democracy, where the people could decide. The larger the group, the less likely it is that everyone would be able to agree on a common set of capabilities for D4D (Kleine, 2010).

To illustrate the CF, Kleine did a case study paying particular attention to micro-entrepreneurs in Algun, Chile. Kleine’s fieldwork was undertaken in 2006, at the height of Chile using the Internet to connect peripheral communities to a knowledge economy. It was undertaken with the special goal of working for “digital inclusion,” as well as addressing social and regional inequality. Kleine explores the effectiveness through a close study of micro-entrepreneurs and info-centres (Kleine, 2010). Following considerations of the CF's conceptual underpinnings, the next section examines an Evaluative Framework that also seeks to operationalise the CA.

2.6.2 Development, Capabilities and Technology – an Evaluative Framework (EF)

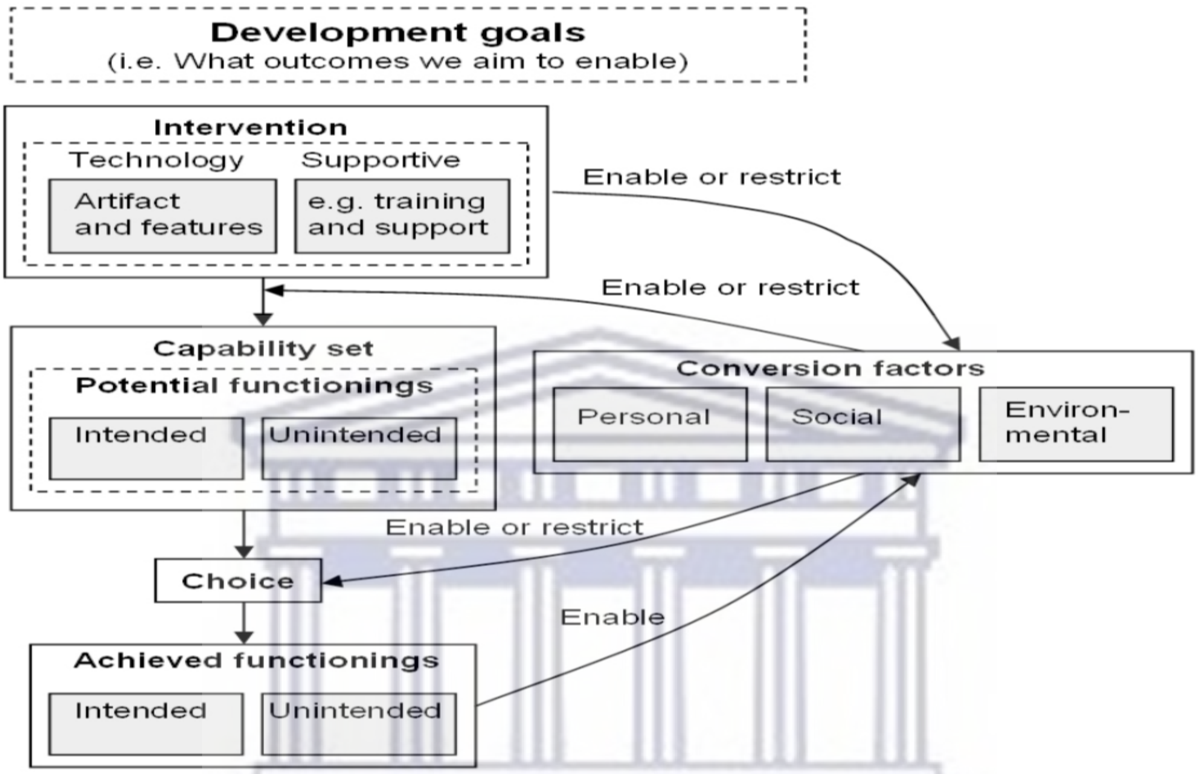


Figure 2-8: Development, Capabilities and Technology – an Evaluative Framework (EF), (Source: Hatakka & De', 2011)

Sen's idea of development as freedom, where human capabilities and functions are seen as essential components to growth, is the foundation of the EF in Figure 2-8. As an alternative to the more conventional methods of assessing development, the EF can be used to assist and evaluate D4D initiatives (Hatakka & De', 2011). Sen's CA starts with the life people choose to live, which is a real bottom-up approach. As it is difficult to operationalise how freedom of choice is measured, this has an impact on development practices where assessment is constrained. Therefore, there is a lot of interest in looking at elaborations and key concepts to use these flaws through the participatory design of technology to record, analyse and assess capabilities and functionings (Andersson et al., 2012).

The CA is built on giving individuals more freedoms or removing restrictions on their freedoms so that they can lead lives that have good causes to appreciate. Sen does not offer any recommendations on how to use the CA when implementing digital technology. According to

Hatakka and De' (2011), the framework tries to operationalise the evaluation process and provide a clear place for technology in Sen's capability-based approach. Figure 2-8 displays a framework Hatakka and De' (2011) created to operationalise the CA.

The EF place the emphasis on actual functionings as opposed to capabilities or potential functionings when evaluating development outcomes produced by D4D initiatives. Technology intervention should involve education and assistance that can affect the decision-making process. The framework then assesses if anticipated or unintended functionalities were attained. The outcomes or choices in converting potential functionings into achieved functionings may be enabled or restricted by conversion factors. The D4D intervention, however, may either increase or decrease the conversion factors.

D4D projects track the enabled capabilities, as well as the contextual elements that affect how those capabilities might work in the future and the decisions that users make. People must possess the capabilities necessary to improve their lives, so they must be the focus of analysis. This applies to both the qualities people value and the constraints on their decision-making (Hatakka & De', 2011).

Based on their competence, opportunity, choice and ability to employ D4D, the functionings were attained. The framework enables us to identify users according to their context and level of system appropriation. By taking a bottom-up approach, actual system functionings are recorded rather than just how the outcome compares to the imposed intervention. All facets of the intervention are covered by the framework, including the backdrop of the conversion factors and the idea of choice (Hatakka & De', 2011). It is important to recognise that the prevalence of digital technology use is a crucial independent variable when examining a wide range of different social phenomena. This can discuss the applicability of digital technology and evaluate the unintended impacts on individual or micro-level progress made in domains unrelated to digital technology. The concept of digital technology inequality is embedded in the "digital gap," which is a multifaceted phenomenon.

2.6.3 The Diffusion of Innovation theory

An innovation adoption curve is used as a decision-making tool by the Diffusion of Innovation (DOI) theory to select the marketing strategies and techniques required to launch new services. Everett Rogers developed a model to assess consumers based on their responses to technology advancements. The five Innovation Adopter Categories include:

1. Innovators – Those who will jump onboard an innovative new product.
2. Early Adopters – A powerful group of opinion influencers.
3. Early Majority – Evaluate a product or innovation's market viability.
4. Late Majority – Hold off until a few generations of advancements.
5. Laggards – The sceptics who may be the last to be on board (Rogers, 2003).

The adoption of an innovation is influenced by five key elements, each of which is present in the five adopter categories to varying degrees. Relative benefit, compatibility, complexity, triability and observability are the key elements (Dearing & Cox, 2018). The adoption curve offers businesses several major advantages, including the following:

- Provides a "first draft" that markets can use to reach customers and emphasises the value of differentiated customer segments.
- Increases the profitability of new goods and services.
- Lessens the dangers of introducing new goods and services.
- Aids in the allocation of scarce resources by managers
- Diffusions often follow a five-stage process that involves individuals of the same social system communicating via numerous channels over a long period (Rogers, 2003).

Awareness of the need for an innovation, decision to adopt (or reject) the innovation, initial use of the innovation and the continuous use of the innovation are the processes by which a person adopts an innovation, thus dissemination is accomplished (Dearing & Cox, 2018).

The Diffusion of Innovation theory can help industry like agriculture and improve the adoption of novel goods, services and concepts. The Innovation Adoption Curve is a useful tool, but it is still merely a model with drawbacks that could mislead innovators when promoting technology-related goods and services. The model frequently oversimplifies a complex reality, is nott adaptable enough to fit every circumstance and does not offer any predictions about how well a product or service will perform after being made available. During the adoption phase, users might reject the new technology at any time (Rogers, 2003).

2.6.4 Porter's Value Chain

To investigate the new potential for digital transformation in a firm, Porter's Value Chain as a framework is utilised to divide business operations into primary and supporting activities. An agricultural value chain (AVC) is the network of people and activities that moves agricultural products from the point of production to the point of consumption. This network includes private, public and service providers. The product gains value at every stage. Support activities exist to help the primary activities by aiding with the manufacturing, marketing and sales of a product (Sealey, 2018).

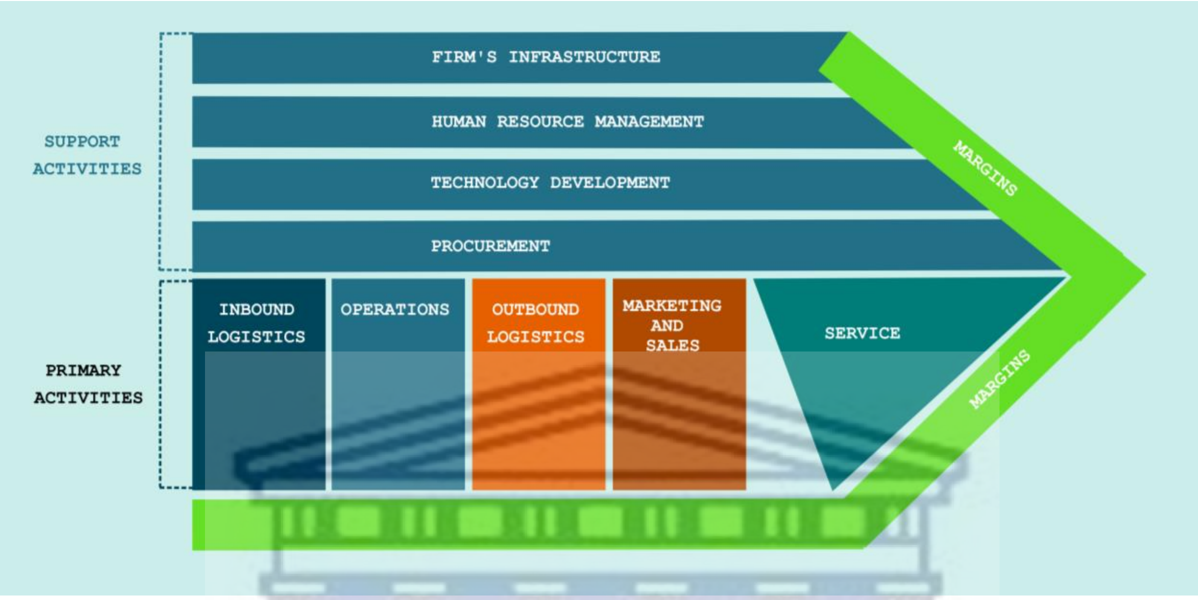


Figure 2-9: Porter's Value Chain. (Source: Sealey, 2018)

The value chain, created by Michael Porter in Figure 2-9, is a compelling tool for segmenting a business's strategically important activities in order to concentrate on the sources of competitive advantage, that is, the particular activities that produce higher pricing costs (Sealey, 2018). To gain a competitive edge, Michael Porter's Five Forces Model provides the ideal mechanism and structure to comprehend the competitive dynamics of the industry. It describes value as the amount a buyer is willing to pay for the goods or services a provider provides (Abbasi, 2017).

The three most important value elements investigated for value chain analyses are perspectives of superior delivered value, customer's perceived value and lifetime value of the customers. The value chain concept emerged from the supply chain, but it emphasises how important it is to produce value at each point of the chain (Kumar & Rajeev, 2016).

The ability to create medium-long-range strategies with short-term practical operational procedures is greatly aided by better data use today. How to use data and change it to get business focus and value is the problem. The application of the well-known Ackoff's DIKW hierarchy (Data, Information, Knowledge and Wisdom) in value chains must be understood at the fundamental level. Digital transformation is the term used to describe this capability of turning data into wisdom in real-time (Ribeiro, 2021).

The value chain of a company is frequently a component of a wider value system that also includes businesses that are either upstream (suppliers) or downstream (distributors), or even both. This understanding of the process by which value is created compels researchers and developers to view each activity, not just as a cost but as a phase that adds value to the final good or service (Sealey, 2018). Infrastructure elements, human resources, some sort of technology and information flow of various kinds are all involved in value-generating activities. The following are the five main criteria that this methodology employs to determine possible possibilities and risks: competitive rivalry, supplier bargaining power, substitutes' threat, new competitors' threat and buyer bargaining power (Abbasi, 2017).

The actions taken to provide value to customers make up the value chain. The fundamental building blocks of competitive advantage are activities and the whole value chain in which they are embedded. The decisions made regarding how the various value chain activities are connected reflect strategy (Ribeiro, 2021).

As a result, digital transformation is a reengineering process that involves the integration of technology that will foster a vision of "real-time" throughout the entire value chain and act as an automation authority, resulting in increased productivity and competitive advantages. With the need to incorporate digital technology as a key and strategic activity of the value chains, the activities of inbound logistics, operations, outbound logistics, sales and marketing and post-sales services are evolving. This implies that a farmer's business plan needs to be properly aligned with digital technology systems. Understanding the various procedures and factors that adhere to a set of best practices techniques that can convert "data and information" into "knowledge and wisdom" is one of the major challenges.

2.6.5 Carroll's Pyramid of Corporate Social Responsibility (CSR)

The definition of Corporate Social Responsibility (CSR) is based on Carroll's pyramid, which contains four categories of responsibilities: abiding by the law, being ethically responsible and making charitable contributions. A corporation is a collection of individuals or a business that has been given state approval to act as a single entity and is legally recognised as such for specific purposes (Carroll, 2016).

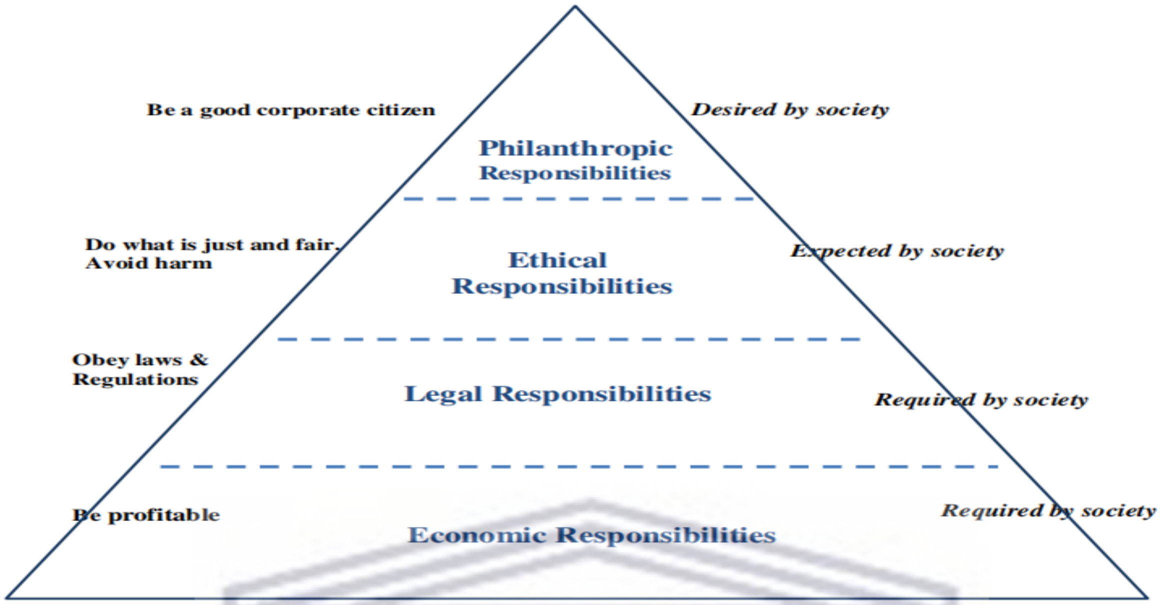


Figure 2-10: Carroll's Pyramid of Corporate Social Responsibility (Source: Carroll, 2016)

According to Carroll's pyramid in Figure 2-10, a corporation must fulfil its obligations at four different levels: economic, legal, ethical and charitable. The bottom level of the pyramid, which is economic responsibility, stands for a company's primary obligation to be profitable. The requirement for the corporate to abide by the law is the second tier of the pyramid. Doing the right thing, acting fairly in all circumstances and avoiding harm are the characteristics of the ethical layer of the ethical pyramid. Philanthropy is at the summit of the pyramid, taking up the least amount of room.

Giving back to society is an important part of CSR, which goes beyond simply doing the right thing. Carroll's pyramid states that in order to engage in charity, a firm must first fulfil all levels of responsibility. An organisation cannot survive if the other obligations are not met.

2.6.6 Resilience Assessment Benchmarking and Impact Toolkit (RABIT)

Being able to adjust to short-term shocks and long-term trends is starting to become the norm for millions of people whose livelihoods depend on crops, cattle and other natural resources. Digital technology can have a significant impact on how resilient rural agricultural livelihoods are to outside stresses (Ospina et al, 2016).

RABIT can be used to measure how well-developed the resilience of small-scale farmers is as a result of the use of digital technology adoption. Nine characteristics or sub-components of resilience are identified by RABIT. Robustness, self-organisation and learning are the three main pillars of resilience. Rapidity, scale, redundancy, flexibility, diversity and equality are the six secondary enablers of resilience. Farmers will be more resilient the stronger these enablers are (Ospina & Heeks, 2016).

For six months, the vulnerable urban neighbourhood of Barrio Luján in San José, Costa Rica, served as the test site for RABIT, which was deployed as a pilot by the University of Manchester's Centre for Development Informatics (CDI) in partnership with the Cooperative Sulá Bats. Additionally, CDI, in partnership with Lutheran World Relief (LWR) and the Gumutindo Coffee Cooperative Enterprise (GCCE), introduced RABIT as a pilot in Mount Elgon, Uganda (Ospina et al, 2016). The goal of these case studies was to identify novel ways to use digital technology to generate or measure community resilience, as well as to evaluate and enhance the effectiveness of development interventions. Thus, the next section will discuss the theoretical framework underpinning this study.

Table 2-5: The strengths and weaknesses of Transformative Theories: (How do a Digital Agriculture Value Chain (AVC) contribute to development?

	Choice Framework	Evaluative Framework (EF)	Diffusion of Innovation Theory (DIF)	Porter's Value Chain (PVC)	Carroll's Pyramid of Corporate Social Responsibility (CSR)	RABIT
Key concept	It transforms Sen's CA into a device for ICT4D systemic analysis. Structure, agency, choice, and results are the four main ideas.	Sen's capabilities approach is operationalised by the EF, which also clearly defines technology's role in the evaluation process.	DIF employs an innovation adoption curve as a tool to aid in selecting the marketing approaches and strategies required to launch innovative services.	PVC is used to divide corporate operations into main and supporting activities in order to investigate new possibilities for digital transformation.	According to Carroll's pyramid, a corporation must fulfil its obligations at four levels, including the economic, legal, ethical and charitable.	Allows for the measurement of resilience baselines as well as the impact of development interventions, particularly the adoption of ICTs, on resilience.
Dimensions	Choice is one of the main outcomes and means of development, and the CF's dimension of choice covers existence, sense, and use of choice. success of choosing	Evaluates the functional outcomes, whether intended or not. The outcomes or options in converting potential functionings and conversion factors into achieved functionings may be enabled or restricted by conversion factors.	Innovators, Early Adopters, Early Majority, Late Majority and Laggards are among the five categories of Innovation Adopters.	Offering value-related activities. Competitive advantage is the value chain in which activities are incorporated. Optional Set: the range of options for how certain actions are connected.	Economic responsibility is the first responsibility, to be profitable. The second is that the company follow the law. Doing the correct thing to prevent harm is referred to as having an ethical layer. At the top is philanthropy.	nine characteristics of resilience are listed. Robustness, learning and self-organisation are the primary three. Rapidity, scale, redundancy, flexibility, diversity, and equality make up the second six. The community are more resilient the stronger these characteristics are
Strengths	can be used as a roadmap for a comprehensive investigation to pinpoint the precise contribution of ICT use to particular development objectives.	The framework enables us to identify users according to their context and level of system appropriation. By taking a bottom-up approach, the system's capabilities are recorded rather than just how	Emphasizes the value of differentiating. First draft available for markets to utilize in contacting customers increases the profitability of innovative goods and services. Lowers the risks when launching	gives compelling arguments for comprehending the changes that structures must undergo to exist and be able to impact their constituents and environment.	A technique for analyzing connections between people, groups, or organizations is social network analysis. It emphasizes conversation (rather than on individual behaviour).	play a critical part in achieving development goals. It offers a comprehensive and long-term strategy to increase resilience in coping with the effects of natural and economic disasters.

		the result compares to the implemented intervention.	new goods and services. Aids in the allocation of scarce resources by management.			
Weaknesses	Model the intricate interactions between agency, structure, level of empowerment, and outcome, balancing the degree of theoretical development of each component. instead of measuring talents, this metric measures functionings. contrasts participatory assessment and monitoring procedures, which form the basis of people-centred development theory, with a focus on individual choices.	There are only a few reliable manuals that explain resilience, how to utilize resilience measurements, and how to use those indicators to lead action that activists and researchers may use.	It doesn't cover everything or reflect the most recent research on the topic	Institutional explanations that are typically static and the persistent issue of quantifying institutional factors in ways other than simple, nominal categories	Decision making is continuously realised based on the ties between actors and the content they deal with ambiguous and power-related issues.	There are only a few reliable manuals that explain resilience, how to utilize resilience measurements, and how to use those indicators to lead action that activists and researchers may use.

2.7 Theoretical framework underpinning this study.

The conceptual framework and theoretical foundations that will be used to perform and analyse this research are covered in this section. It offers a review of the concepts employed in D4D initiatives to carry out rural development. The study investigates how D4D can contribute to the growth of small-scale farmers.

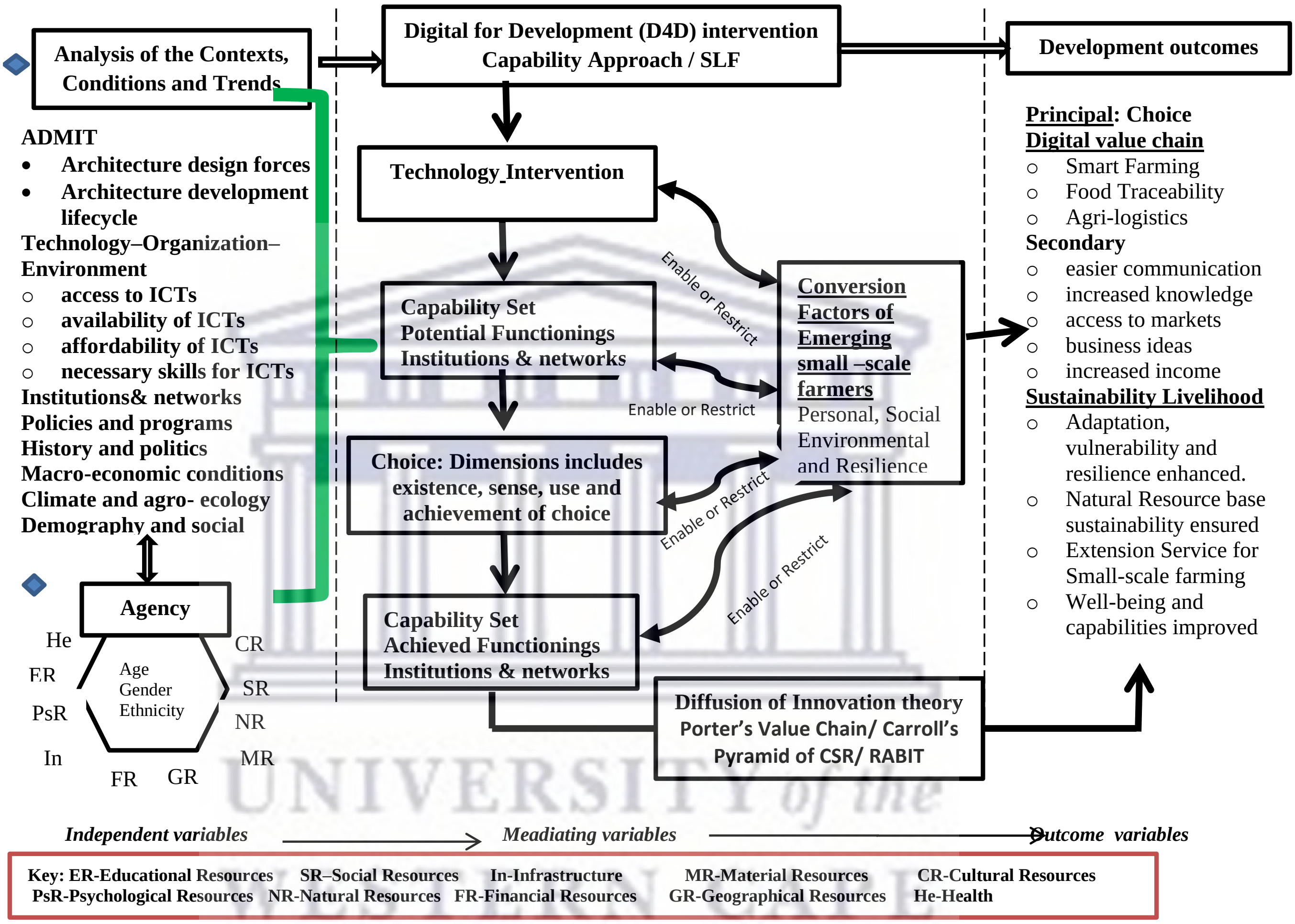


Figure 2-11: Framework underpinning this study (Source: Adapted from Kleine, 2010; Hatakka & De', 2011)

Figure 2-11 shows the theoretical framework model diagrammatically with the key concepts and dimensions. The purpose of this study is to investigate the variables that influence the usage of digital technology in agricultural value chains, and it does so by utilising development theories (CA and SLF), the theories conceptualising digital technology adoption (TOE, ANT, IT and ADMIT) and theories on transformative processes (CF, EF, DIF, PVC, CSR and RABIT). Theories on transformative processes link digital technology adoption and AVC development. The incorporation of digital technology in the value chains of small-scale farmers is examined and explained using this framework. The framework assists to pinpoint the various political, social and economic factors that influence how small-scale farmers use information technology. These political, social and economic factors that impact digital technology adoption into the value chains of small-scale farmers are discussed next.

2.8 Factors affecting digital technology adoption in Agriculture Value Chains (AVCs)

An AVC is described as a sequential process that transforms resources and raw materials into goods for the market earlier in Section 2.6.4. This enables a group of individuals and processes to take a fundamental agricultural commodity from its point of origin in the field to its point of consumption. Understanding the traits of agricultural products, various farmer and customer groupings, and the potential operational roles of a digital service are crucial for evaluating the implementation of digital technology in AVC. These elements support the service's cost structure, which, combined with stable income sources, has an effect on the sustainability and scalability of a digital business (Joiner & Okeleke, 2019).

The NDE therefore comprises value-creating digital information that improves, substitutes for, or supplements economic interactions in an increasing number of processes that create economic value (Graham, 2019). By connecting people to possibilities and advantages, more digital technology adoption in AVCs could assist governments in accelerating the transformation of small-scale farmers. Digital technology's role as an enabler could make sense in the short term while delaying addressing the true underlying issues (Deichmann & Mishra, 2019). According to Deichmann and Mishra (2019), the emphasis should be on bolstering the business climate, enhancing skill development and holding the public sector accountable to ensure that digital technology is used to empower the poor. This supports the necessity to understand the various economic, political and social variables influencing digital technology adoption in small-scale farmers' AVCs, which is covered in more detail next.

2.8.1 Economic Factors affecting digital technology adoption in AVCs

Interventions involving digital technology can have a positive impact on the economy by lowering costs and boosting productivity and profitability. Reducing transaction costs in AVCs can be achieved by connecting small-scale producers to markets (El Bilali & Allahyari, 2018; Joiner & Okeleke, 2019). Digital interventions deal with a variety of weaknesses and inefficiencies, including data sharing and analytics, market access and financial access, as well as tracking and traceability (El Bilali & Allahyari, 2018; FAO, 2013; FAO & ITU, 2017; GSMA, 2018; OECD, 2019).

The use of digital technology tools and food traceability systems has become crucial for risk management in order to enable compliance with food safety laws (FAO, 2013; FAO & ITU, 2017; OECD, 2019). For the benefit of consumers farther down the supply chain, they trace food to determine its origin (Deichmann et al., 2016; El Bilali & Allahyari, 2018; FAO, 2013). Digital technologies like Artificial Intelligence (AI) and Blockchain help facilitate export traceability requirements compliance (OECD, 2019).

Any digital intervention in AVCs begins with digital payments (GSMA, 2018) where delivering financial services, increasing the effectiveness of financial transactions and expanding market potential are three obstacles to establishing a holistic strategy (Jackson & Weinberg, 2016; Mattern & Ramirez, 2017). In the past, small farmers have struggled with their lack of access to capital and other financial services. Financial service providers now have more opportunities to approach the persistent problem of financial exclusion through the prism of digital technology (Wisdom et al., 2018). Adoption of digital technology could lead to improved access to credit, payments or collateral management (FAO, 2013; Joiner & Okeleke, 2019) as it makes it possible to send money quickly and securely for remittances, agricultural subsidies and product payments (Deichmann et al., 2016). Financial services can be shaped by digital innovation by providing more specialised goods to small-scale farmers to fit their unique requirements and capacities (Deichmann et al., 2016; FAO, 2013; Joiner & Okeleke, 2019).

Digital technology intervention enables effective logistics to boost capacity utilisation, improve transportation coordination and optimise supply chains (Deichmann et al., 2016). Digital marketplaces increase external market links for the purchase or sale of a variety of commodities, goods and services, which improves supply chain efficiencies (FAO, 2013; Maru et al., 2018; OECD, 2019).

Digital technology can expand knowledge by introducing small-scale farmers to new methods of extension service delivery (Deichmann et al., 2016; Joiner & Okeleke, 2019). Numerous digital technologies, including those used in food processing, distribution and consumption, can be incorporated into precision agriculture to increase food production (El Bilali & Allahyari, 2018). By facilitating the adoption of better inputs and weather forecasts and encouraging agricultural investment decisions, digital technology increases farm productivity (Deichmann et al., 2016).

2.8.2 Political Factors affecting digital technology adoption in AVCs

In Global Value Chains (GVCs), the state can have a significant impact on small-scale farmers' AVCs in relation to each of its four responsibilities as a facilitator, regulator, producer and buyer (Horner & Alford, 2019). Promoting agricultural innovation, assisting in the development of rural capacity and offering pro-poor innovations for rural social development are the three areas where the state may play a critical role in facilitating inclusive rural transformation (Habiyaremye et al., 2019). Given that the state does not operate in an institutional vacuum, it is crucial to comprehend how the state functions in GVCs. The state has always served as a facilitator, but more lately, it has emerged as a regulator. On the other side, the state secretly acts as a buyer while the producer's job has been neglected (Horner & Alford, 2019).

Inequality is a result of the state's various levels of operation and array of policies, which can produce either favourable or unfavourable results (Habiyaremye et al., 2019). As a facilitator, the state can help AVCs navigate the difficulties of the global economy by enacting regulations that limit the actions of businesses operating in GVCs. The state as a producer can own businesses that compete for market share with other businesses. The state as a consumer can buy small-scale farmers' produce through public procurement. Roles played by these many VCs roles by the state may be influenced by factors related to the economy, society or environment (Horner & Alford, 2019).

The government should be firmly committed to investing in smart agriculture and developing public goods associated with these technologies that benefit the majority of participants, particularly small-scale farmers (Kanoktanaporn et al., 2019). The government can use innovation policy to improve agricultural production techniques and intervene by supporting inclusive transformational capacity building and ensuring the availability of pro-poor social innovations (Habiyaremye et al., 2019).

2.8.3 Social Factors affecting digital technology adoption in AVCs

Climate change and demographic pressures in Africa make it nearly impossible for smallholder farmers to make a living. On the other hand, the region's urbanisation and economic expansion are opening new markets for both fresh and processed goods. Developing small-scale farms into lucrative, commercial enterprises and enhancing their connections to expanding food markets are necessary to address the issues of rural poverty and vulnerability (Begashaw et al., 2019). Digitalisation can enhance resilient AVCs by increasing openness and enhancing information sharing, process automation and documenting production (OECD, 2019).

Interventions involving digital technology produce favourable, environmentally sustainable results. The more effective use of resources and inputs is increased by these strategies. They also lessen food loss due to waste, greenhouse gas emissions and other environmental impacts (El Bilali & Allahyari, 2018). For investors, donors, companies, governments and other stakeholders, digital technology creates enormous social value around the main objectives of the SDGs (Joiner & Okeleke, 2019).

Digital technology interventions have social benefits such as enhancing food supply chain transparency and facilitating information access for all participants in the food chain. The initiatives promote networking among those involved in the food chain, which strengthens small-scale farmers' connectedness and contributes to increased food safety (El Bilali & Allahyari, 2018). Adoption of digital technology has the potential to increase the financial stability, food security and asset value of rural households through better asset management techniques and interventions that provide more opportunities (Deichmann et al., 2016). They enhance farmers' lives, increase productivity, decrease waste and promote financial and digital inclusion in rural communities (Joiner & Okeleke, 2019).

Small-scale farmers face significant obstacles when adopting digital technology, including a lack of training and awareness, a lack of adequate infrastructure and expensive costs. It is crucial to give women and young people access to create and implement digital technology adoption in AVCs of small-scale farmers. Through improved access to knowledge on how to increase agricultural productivity and connections to funding and market opportunities, digital technologies empower women and young farmers (Bayer, 2018)

Agriculture can be transformed by digital technologies, but many positive instances with promise have not always been scaled as envisaged (Deichmann et al., 2016). To create institutions and governance regulations to ensure that digital technology is used to empower the poor, it is crucial to comprehend the interdisciplinary nature of the actors. The next section investigates the governance and institutional implications when adopting digital technology in the AVCs of small-scale farmers.

2.9 Governance and institutional implications

This study argues that the first step in developing a comprehensive strategy for implementing digital technology in small-scale AVCs is to identify the institutional and governance frameworks required to steer digital technology adoption towards its objective. Small-scale farmers will be able to do this to increase productivity and sustain sustainability while also realising the full potential of their current skills.

Earlier, our literature review highlighted that the adoption of digital technology in AVCs of small-scale farmers' is affecting many facets on a global basis. Institutional and governmental support is required to change small-scale farmers' use of digital technology. Small-scale farmers can be empowered by digital technologies to change their AVCs into collaborative digital models that are more flexible, agile and sustainable. Collaboration is necessary since local silo-based approaches frequently fail to choose the most appropriate digital solutions and gain the greatest benefits.

To strengthen and increase agility, efficiency and effectiveness of small-scale farmers' AVCs, the proper skill sets, procedures and tools must be in place. Digital technology adoption policies must work on projects that will get them ready for the NDE to accomplish these goals. Considering this, the governance and institutional elements influencing the adoption of digital technology in AVCs of small-scale farmers are discussed in this section.

2.9.1 Governance implications

Global Value Chains (GVCs) are shaped differently as a result of the fact that not all nations have the same authority and competence to establish and carry out their various GVC-related functions. It is becoming clearer that states shape GVCs in addition to the fact that GVCs impact the state's policy alternatives (Horner & Alford, 2019). Identification of system resilience and institutional resilience is crucial for the development of AVC resilience. Consequently, it is critical to apply the principles, assessment or measurement approach and involvement scope in the appropriate manner (Vroegindewey & Hodbod, 2018).

The importance of the state and the relationship between strong private and public players in GVCs should be acknowledged and further investigated in the current global political economy. This can offer vital insights into how states can and should control GVCs in conjunction with private actors (Horner & Alford, 2019). While donors and investors must invest in viable services and consider regional market realities, governments must support farmer operations and create an enabling regulatory environment (Joiner & Okeleke, 2019).

The availability and quality of IT infrastructure, as well as data governance circumstances, have an impact on small-scale farmers' use of digital technologies (EIP-AGRI, 2017). Most people agree that GVCs consist of connections between several players. Practitioners and scholars need to be aware of the influence that certain corporations can have on the capabilities and behaviours of small-scale farmers and trading partners (Horner & Alford, 2019). Since there is more information flow and control along AVCs, the integration of models can go beyond simply connecting AVCs players (Jackson & Weinberg, 2016).

To make it easier for rural areas to absorb outside digital solutions locally, the state must play a crucial role in fostering local capacity building and bridging knowledge gaps between innovation providers and those communities (Habiyaremye et al., 2019). The government should assist both public and private sector organisations in their R&D efforts and promote private investment in accessible, low-cost products and services. Additionally, it should promote information and data sharing while providing adequate protection for intellectual property rights through trials and the launch of pilot projects prior to larger-scale implementations (Kanoktanaporn et al., 2019).

2.9.2 Institutional implications

Communication and the exchange of information and knowledge between two or more actors are made possible by information sharing. Information analytics analyses data and reports findings for internal reporting and efficiency, as well as to partners, customers or other parties (FAO, 2013). Digital platforms enable knowledge to be combined across sectors internationally and are no longer defined by local institutional frameworks (Quinones et al., 2017).

Digital Innovation Hubs (DIHs) as an institution can play a critical role in assisting the digital transformation in the AVCs of small-scale farmers, according to the European Innovation Partnership Agricultural Productivity and Sustainability (EIP-AGRI, 2017). To expand agricultural support services and build digital rural infrastructure, DIHs can also encourage international, sub-regional and local cooperation. Increasing the supply and effective demand will lower costs and boost profitability (FAO, 2018).

The worldwide AVCs are being participated in by new actors because of the global food system's digital change. Understanding your trading partners is crucial because digital trade platforms permit the participation of new parties in AVCs (OECD, 2019). The institutional digital AVC model must be developed by all agricultural stakeholders. Farmers, the government, research groups, international organisations and financial institutions are stakeholders in this situation (Awuor et al., 2016). According to EIP-AGRI (2017), DIHs make it simpler for firms to access markets by establishing connections between competence centres to support the small-scale farming sector and digital technology suppliers, specialists and investors.

The success of interventions using digital technology depends on larger institutional support to promote political empowerment, the development of human capital and to address wealth inequality (El Bilali & Allahyari, 2018). For agricultural transformation to be inclusive and growth-friendly, a coordinated strategy is required to address every issue at once. Agriculture strategies should be in line with other sector strategies and the right infrastructure. This plan could be an efficient way to combat rural poverty and foster economic development (Begashaw et al., 2019). It is consequently vital for farmer-centred involvement and collaboration to solve institutional and governance challenges while designing legislation to integrate digital technology in the AVCs of small-scale farmers.

2.9.3 Collaboration and participation

A country's rules and its overall regulatory framework must be considered while using digital technologies (Bayer, 2018). The main objective is to develop the enabling policy environment to increase investment capital into businesses and projects that promote climate-smart agriculture for small-scale farmers (FAO, 2018). To create a shared knowledge of the fundamentals of digital technologies for sustainable production and innovation, this should involve surveying international fora. Additionally, by highlighting a need for action, the creation of digital platforms and initiatives should encourage sound policy practices for the adoption of technology in agriculture to assist small-scale farmers (FAO et al., 2018). There is thus a case for the necessity of collaboration, farmer participation and the state's responsibility in devising solutions for small-scale farmers' AVCs to incorporate digital technology.

African agricultural policy should increase domestic agriculture's competitiveness with the rest of the world, both domestically and internationally, especially in terms of quality (Begashaw et al., 2019). The creation of DIHs is necessary for the expansion of the digital services sector and to scale-out in rural areas (Matto, 2018). Legal and regulatory restrictions must be lifted for policies to guarantee that efficient procedures are in place. Small-scale farmers should receive direct help from businesses that offer digital technology services (FAO & AUC., 2018).

The widespread use of acceptable technology for risk management, the environment and agriculture can be facilitated by government policy. The sustainable utilisation of land, water and biodiversity resources should be improved by policy decisions about digital technology adoption in AVCs (FAO et al., 2018). They should educate smallholder farmers about the advantages of adopting digital technology, such as fast access to agricultural information from reliable sources (Matto, 2018).

Due to the extremely varied results and significant wealth disparity within countries, there is currently a need to work towards more socially just distributive outcomes (Horner & Alford, 2019). Countries should encourage policies and practices that give chances to small-scale farmers, rural families, women and young people in the agro-processing business to establish an integrated, inclusive and equitable global food system (Begashaw et al., 2019). Young people are best positioned to take advantage of the prospects and may find agriculture more appealing because of innovations in digital AVCs. They are more open to new technologies, and more complex digital technology requires more training and skilled extended support to provide excellent outcomes (Bayer, 2018).

Understanding what farmers value is essential when creating digital AVCs solutions to ensure that the products are widely adopted and profitable (Wisdom et al., 2018). Two strategic methods, the method of community engagement and the method of collaboration are necessary to meet the information needs of farmers (Awuor et al., 2016). As part of the community participation approach, farmers must be included in the planning and implementation of these digital technology solutions. When the government supports them and local farmers are more involved in the design and implementation, innovative ventures have a higher chance of success (Habiyaremye et al., 2019). Bayer (2018) supports this and argues that small-scale farmers are more inclined to adopt digital solutions if they perceive them to be trustworthy and relevant. As a result, small-scale farmers must work together and be involved in the creation of policies that will encourage the adoption of digital technologies.

The collaborative approach necessitates that all information providers share a common aim of swiftly disseminating the information within their jurisdiction because farmers' information needs are extensive and cannot be met by a single source (Awuor et al., 2016). The local market's decision to adopt digital technology and how it balances these factors to foster consumer loyalty and trust relies on the local market (Joiner & Okeleke, 2019). According to Awuor et al. (2016), increasing collaboration among the stakeholders will allow them to complement one another and guarantee that each party's interests are addressed. Organisational models must be adaptive to local market conditions in order to take advantage of the business potential provided by digital AVC, mandating scalable and sustainable business strategies (Joiner & Okeleke, 2019).

To guarantee that small-scale farmers with limited resources have fair and timely access to agricultural knowledge, agriculture stakeholders should encourage collaboration and knowledge sharing, promoting the creation and adaption of material in local languages and contexts (FAO et al., 2018). Digital AVCs must reach critical mass for real improvement to take place, otherwise, digital liquidity would be limited (Jackson & Weinberg, 2016). Agriculture stakeholders should encourage public-private collaborations with cooperatives, farmer organisations, universities and research facilities to ensure inclusive, effective, inexpensive and sustainable digital technology services (FAO et al., 2018).

Agreements for data-sharing across AVCs partners can be created to reduce uncertainty and justify investment in information analytics techniques. To foster collaboration and optimise the advantages and value of data collection and analysis, data sharing should initially be a fundamental element of business models (FAO, 2013). The potential of digital AVCs in resolving some of these restrictions can be determined by conducting in-depth research that enables implementers of digital AVCs to evaluate the obstacles to increased procurement performance and the competitiveness of farmers and purchasers (GSMA, 2018). It is important to look at a framework for localised implementation to address all these areas of concern for digital technology adoption in AVCs of small-scale farmers such as governance, institutional implications, collaboration and participation. The next section concludes this study chapter which would provide a basis for Chapter 3.

2.10 Chapter Summary

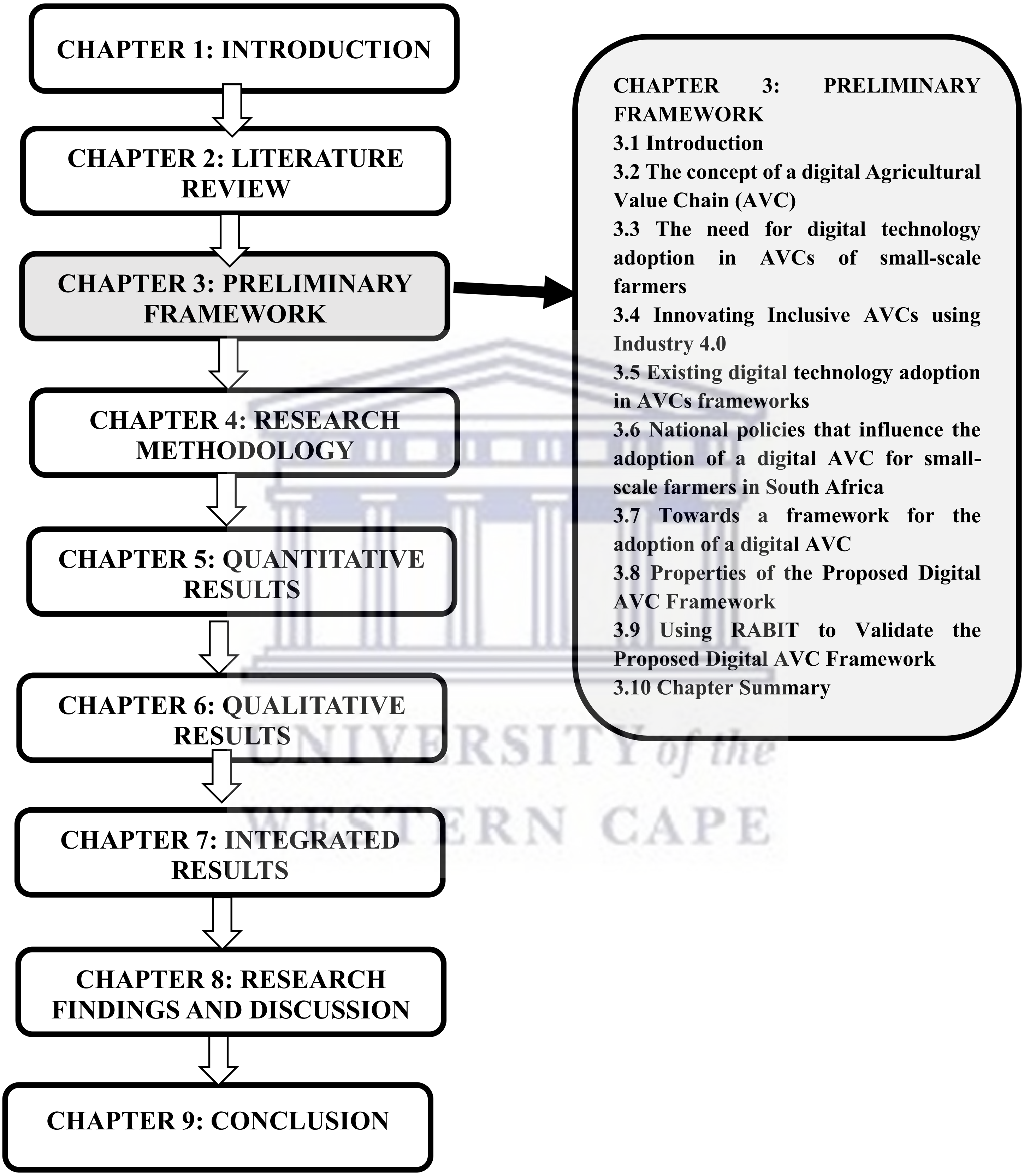
This chapter outlines a framework for implementing digital innovation in sustainable small-scale agriculture in South Africa. It examines factors influencing farmers' adoption of digital technology in AVCs and explores governance and institutional implications. The chapter also reviews three categories of "Digital for Development (D4D)" theories: development theories, digital theories, and "transformative process" theories in AVCs, referred to as "4".

The chapter explores digital innovation, D4D, and NDE in AVCs, focusing on small-scale farmers. It explores governance requirements for inclusive digital platforms and social, political, and economic factors affecting adoption. The chapter also highlights institutional difficulties in policy considerations, which can help address governance issues.

Digital technologies can help small-scale farmers participate in AVCs with reduced restrictions, increased access to services, and lower coordination costs. Mobile money and partnerships can leverage assets. However, maintaining viability is challenging due to underutilization in informal supply chains. Stakeholder collaboration is needed for digital policies promoting inclusion and sustainability.

The chapter explores the resilience of small-scale farmers in South Africa and proposes a digital technology adoption framework for AVCs. It emphasizes regional solutions and a conceptual framework for interconnecting AVCs nationally, regionally, and internationally.

CHAPTER 3: DIAGRAMMATIC OVERVIEW



3 Chapter 3: Preliminary Framework

3.1 Introduction

The preceding chapter covered the research on how small-scale farmers might become more involved in Agriculture Value Chains (AVCs) by adopting digital technologies. Chapter 2 also noted that small-scale farmers face substantial difficulties and hurdles to adopting digital technology, even though doing so increases efficiency in AVCs. It helped us comprehend the intricate phenomenon of how economic, political and social elements influence Digital for Development (D4D) related to AVCs.

The preceding chapter also emphasised the need for an interdisciplinary understanding of the implications for governance and institutional challenges. This could explain why some actors in AVCs benefit more than others and why this trend is mirrored locally and at a global level. The involvement of the state in governance and institutional support is crucial to facilitate the participation and collaboration of different stakeholders and to share power and economic value among the actors in AVCs more fairly. The significance of comprehending these barriers to expansion in South African digital AVCs and how to get beyond them has not been examined. The applicability of the current frameworks for this complicated phenomenon is disputed by critics, who claim that societal ramifications have been overlooked. The lack of a localised framework for development implementation to support small-scale farmers in South Africa to adopt digital technologies in AVCs has been emphasised. The adoption of digital tools to aid small-scale farmers must be supported by this framework. This should establish efficient communication to deal with information asymmetry and a lack of access to knowledge. Research, development and innovation may all benefit from this.

With the aforementioned in mind, this chapter provides an answer to the question "*What are the components of a framework that can unmask strategies and policies to implement digital AVCs for small-scale farmers in South Africa?*" The answer to this question lays the groundwork for future studies on the significance of fostering innovation, training, partnership and involvement.

An alternative conceptualisation of a framework for the adoption of digital AVCs is provided in response to the research question. This chapter develops a comprehensive conceptual framework for implementing localised D4D in AVCs of small-scale farmers. A variety of digital AVC implementation frameworks were evaluated. These were then analysed and linked with potential D4D-related policies and strategies in South Africa. In the end, a framework is proposed that includes a list of the institutional structure, digital services and digital technology design architecture.

The structure of this chapter is organised as follows: Section 3.2 The concept of a digital AVC, Section 3.2 discusses the relationship between systems approaches and problem context, Section 3.3 discusses the need for digital technology adoption in AVCs of small-scale farmers, Section 3.4 discusses how to innovate inclusive AVCs using Industry 4.0, Section 3.5 discusses existing digital technology adoption in AVC frameworks, Section 3.6 discusses national policies that influence the adoption of digital technology in AVC of small-scale farmers in South Africa, Section 3.7 takes us towards a framework for the adoption of a digital AVC, Section 3.8 presents the properties of the proposed digital AVC framework, Section 3.9 discuss using RABIT to validate the proposed digital AVC framework and Section 3.10 presents the chapter summary. The next section discusses the concept of a digital AVC.

3.2 The concept of a digital Agricultural Value Chain (AVC)

The sequential linkages through which resources and raw materials are transformed into goods for a market are referred to as a value chain. An Agricultural Value Chain (AVC) is a collection of individuals and activities that transport agricultural products from the point of production to the point of consumption, adding value to the product at each stage (ADBG, 2013). A nation can achieve more successfully its agricultural goals with the help of digital solutions to a variety of agricultural issues. New digital technologies that open up options and experiences for customers based on digital capabilities in AVCs are seen as transformation agents (Ungerer et al., 2018).

Sealey (2018) proposes Porter's value chain as a framework to divide business operations among primary and supporting activities to investigate new potential for digital transformation in an organisation. The production, promotion and sales of a product are considered primary activities. In contrast, support activities serve to amplify the impact of the primary activities (Sealey, 2018).

Information systems' strength and application are employed as a strategic, value-adding decision-making tool to adopt a digital AVC. This goes beyond the first definition of Michael Porter's value chain, which was only a simple technology support activity (Sealey, 2018). It is critical to comprehend how data, information, knowledge and wisdom fit into value chains. An internal process called digital transformation enables organisations to turn data into knowledge and intelligence (Ribeiro, 2021).

Table 3-1: Value drivers driving value in Digital Agriculture Value Chains (AVCs)

Value drivers	Productive, efficient, inclusive, sustainable, transparent, resilient VCs
Operational excellence	Improved yields and reduced water, land, energy, and pesticide consumption per ton of food; As a result, the demand for food is met sustainably and at a reasonable price; less food waste; efficient insurance and capital markets
Supply chain orchestration	Food security increased; increased domestic production and frictionless markets for imports; improved first- and last-mile delivery efficiency; additional disintermediation the rise of intermediates with higher value-added; Better connections between buyers and sellers
Transparency	Supply chains that are transparent and traceable and connected VC that gathers data in real-time for useful insights

(Source: Adapted from Lee et al., 2017)

The value drivers in Table 3-1 explain how digital AVCs can become more resilient, productive, efficient, inclusive, sustainable and transparent. The three value drivers are supply chain orchestration, transparency and operational excellence. Agricultural production and the value chain, including post-harvest, transportation and storage, are both improved by digital innovation (Corallo et al., 2018). Digital platforms for food traceability have emerged as essential risk management tools for containing food safety issues and fostering customer confidence (FAO & ITU, 2016). Increased intra-company efficiency and market competitiveness are benefits of digitally enabled marketing (Corallo et al., 2018).

The digital economy offers technologically driven answers to many agricultural problems and opens doors for achieving agricultural objectives (Stugeon, 2017; Ungerer et al., 2018). Agriculture production, transportation and storage can be improved by digital innovation, and marketing that is enabled by technology boosts productivity and competition amongst businesses (Corallo, Latino & Menegoli, 2018; Krone & Dannenberg, 2018). To quickly maximise their market value, AVCs must incorporate information systems methods as a core activity (Ribeiro, 2021).

According to FAO (2015), digital technologies boost small-scale farmers' access to AVC by enabling new methods of delivering extension services (Deichmann et al., 2016). Digital technologies can assist agriculture in gaining better access to commercial markets by facilitating information access and removing geographical barriers by bringing farmers and buyers together (Krone & Dannenberg, 2018).

<table>
<tr><td>Farmer’s Suppliers (Input supply Industry)</td><td>Farmers/ Producers</td><td>Processing post-harvest and storage</td><td>Distribution and Retail</td><td>Consumer</td></tr>
<tr><td colspan="5">Technology Service Providers</td></tr>
<tr><td colspan="3">AI and IoT Big Data Collection and Analysis</td><td colspan="2">E-business</td></tr>
<tr><td></td><td colspan="2">GNSS precision agriculture</td><td></td><td>Blockchain Traceability</td></tr>
<tr><td></td><td colspan="2">Smart farming and Smart irrigation</td><td></td><td></td></tr>
<tr><td colspan="5">ICT digitalized Communication (broadband)</td></tr>
<tr><td></td><td colspan="3">Robotics Automation</td><td></td></tr>
<tr><td colspan="5">Blockchain smart contracts</td></tr>
</table>

Figure 3-1: Digital AVC vertical integration and services. (Source: Adapted from Pesce et al., 2019)

Digital technology can lead to vertical integration, which integrates two or more traditionally separate manufacturing and/or distribution phases. Some various reasons or benefits lead to increased digital innovation in AVCs (Amadeo & Rasur, 2022). The vertical integration of a digital AVC and the available digital technologies are shown in Figure 3-1.

By allowing all stakeholders to engage in more sectors of the value chain, a vertically integrated business model provides a legacy of long-term sustainable value that benefits consumers, communities and shareholders more broadly. Through vertical integration, stakeholders establish their manufacturers, distributors or suppliers as opposed to outsourcing these functions (Odeyale, 2007).

Commercial AVCs play a crucial role in helping to reduce poverty in underdeveloped nations (ITU, 2016). Agriculture is becoming more knowledge-intensive, thanks to digital technologies which also offer new opportunities to provide extension services that are adapted to local conditions (Deichmann et al., 2016; NAHF 2017). Rules governing food traceability must also be followed in AVCs. To reduce safety risks and improve marketing, digital systems retain information about how food is processed (Corallo et al., 2018; FAO & ITU, 2016).

AVCs must abide by national and international laws when marketing is aided by information on food items and related processing stages (Corallo et al., 2018). The primary link between humans and the environment is the flow of food through the vertical column (FAO, 2015). Consequently, it is discussed in the next chapter why digital technology adoption in small-scale farmers' AVCs is crucial to the success of agriculture in South Africa.

3.3 The need for digital technology adoption in AVCs of small-scale farmers

The goal of South Africa's development of small-scale agriculture is to correct the unfair land ownership practices that were prevalent under Colonialist and Apartheid regimes in the past (DAFF, 2016). One way to think of South African agriculture is as a dual system, with primarily white well-developed large-scale capital-intensive farmers on the one hand and primarily black less-developed smallholder and subsistence farmers on the other with limited resources (Thamaga-Chitja & Morojele, 2014). Following the end of Apartheid, unequal development persisted as large-scale, subsidised white farmers, supermarket chains and agribusinesses competed against unsubsidised black peasant farmers (DAFF, 2016).

The importance of information must be emphasised in order to address the challenges in the South African small-scale agriculture sector (SDSN, 2015). Smallholder farms are not receiving information about digital AVCs, which prevents them from being knowledgeable about the topic (DAFF, 2016; Heeks, 2018). The lack of economies of scale, availability of land, credit and technology are among the issues that digital AVCs can aid in overcoming (Malan, 2018). As a tool for commerce, standardisation, traceability and integrity, digital technologies close the information gap in AVCs (OECD, 2019).

Small-scale farmers can employ digital connectivity and tools to get over development obstacles (Graham, 2019), but they occasionally do not understand the size and extent of the reforms required (Juma, 2019). Small-scale farmers in South Africa frequently lack economies of scale, and their chances of producing enough food are harmed by limited access to agricultural land, credit, technology and other resources (Malan, 2018). To boost agricultural productivity and advance food security, small-scale farmers must adopt digital technologies in their AVCs (Mago & Mago, 2015).

Lack of expertise in the agriculture ministries and poor extension services for small-scale agricultural development is to blame for the government's incapacity to undertake digital technology adoption initiatives for small-scale farmers (Pionett & Bilgi, 2011). The government frequently misunderstands the measures required to remove development-related obstacles (Graham, 2019; Juma, 2019).

Table 3-2: Benefits of new digital technologies across different players in AVCs

Farmers	Enhanced livestock health, lower production costs, decision support, and increased productivity
Consumers	Better product quality is a result of real-time data and production information.
Public properties	Accurate appraisal of farms and fields
Environment	Reduced water uses because of improved environmental, energy, and climate management
New players	New potential for SMEs in business, new technological players in agri-food venture capital, and the growth of start-ups

(Source: Pesce et al., 2019)

Table 3-2 discusses the benefits of new technology for a variety of stakeholders in a digital AVC, including farmers, consumers, the environment and new players. New players can be characterised as the emergence of start-ups, new technology in AVCs and commercial prospects for Small and Medium-sized Enterprises (SMEs). Small-scale farmers may better assess their costs, make better decisions, have easier access to credit and share agricultural expertise among AVCs with the aid of digital tools (Campion, 2018).

The government should encourage the use of digital AVCs to boost food security and agricultural productivity (Mago & Mago, 2015) by giving small-scale farmers comprehensive support (NAHF, 2017). Reorienting and updating agricultural advising services to include greater knowledge and technology is necessary. So, in order to remove barriers that impede small-scale farmers from embracing digital technology, it is imperative to understand how to construct inclusive digital AVCs, which is discussed next. This could open new business prospects for technopreneurs and agripreneurs to launch start-ups or expand established SMEs.

3.4 How to Innovate Inclusive Agriculture Value Chains using Industry 4.0

By integrating business and logistics processes online, Industry 4.0 connects the physical and digital worlds (Fonseca, 2018). To assist production in making decisions in real time, connected smart systems sense, forecast and engage with the outside environment, production consequently becomes more cost-effective, efficient and sustainable (Sirimanne, 2022).

The use of technology determines the fundamentals of Industry 4.0 development in any community. Every economy will become underdeveloped if a technology acquisition and capabilities strategy is not prioritised in planning (Adeoti, 2019). New business models with quicker operations and product delivery to markets are suggested by industry 4.0. Stronger consumer loyalty results from user participation in product customisation (Fonseca, 2018).

Governments must persuade the business sector to advance Industry 4.0 through finance and investments (Sirimanne, 2022). Industry 4.0 must be implemented successfully, which calls for strong leadership, appropriate skills and the removal of obstacles (Fonseca, 2018).

In order to link people, industries are increasingly using computer-based automation, including artificial intelligence, the Internet of Things, robot technology and big data (Siregar, 2019). There is a ton of doom and gloom around the development of jobs in the digital era of Industry 4.0. As technology changes workplaces, digital disruptions give rise to workforces with uncertain futures. Certain skills have a shorter shelf life since jobs are changing more frequently and some professions are disappearing (Bowles, 2016).

The rise of technopreneurs, who are frequently university graduates and young people, offers a path and direction for realising the inclusive industry 4.0 vision (Siregar, 2019). Technopreneurs are essential to finding technical solutions to issues in many spheres of the economy. To be more competitive, new enterprises are founded or old ones have their resilience strengthened. New vigour and motivation are given to the economy, which leads to long-term expansion, shared wealth and ultimately increased global competitiveness (Adeoti, 2019).

The reduction of inequality and the development of the most disadvantaged members of society are the main goals of inclusive development. In places of exclusion, equal chances are created by combining local indigenous knowledge with modern knowledge. There are many prospects for graduates and young people now that Industry 4.0 has advanced, thanks to science and technology. The future of talent development must be addressed. There is a need to change how power is now distributed and look beyond the technocratic solution to stimulate the chances for the poorest. Graduates and young people might not be able to take advantage of chances without understanding the relevant situation (Gupta & Ros-Tonen, 2015).

Industry 4.0 has ushered in a new era of entrepreneurship that is now vital to the health of economies and esteemed for its stimulation of innovation to compete on a global scale (Siregar, 2019). Graduates and young people are developed through entrepreneurial awareness, capacity building and mentoring in entrepreneurship development programmes, which might result in new entrepreneurs. To comprehend and be inspired to generate new ideas, knowledge is offered. At the programme's conclusion, an activity called incubation creates new, independent business owners (Hati, et al., 2018). Rural communities can benefit from using innovation centres to attract investment and create job possibilities (Gupta & Ros-Tonen, 2015).

Governments that are reluctant to take advantage of quick technology advancements will suffer from Industry 4.0. For the most disenfranchised, redistributing social benefits and educational chances is not always enough (Siregar, 2019). Taking advantage of opportunities and fostering partnerships will provide you with a competitive advantage. Instead of creating linear products, there is a need to create network platforms. Due to this disruption, traditional hierarchies are being replaced by flatter services in both workforce design and organisational structures. Robotics, automation and cloud technology are used to streamline production by displacing regular skilled personnel (Bowles, 2016).

Technopreneurs play an admirable function in the economic competitiveness and national growth of contemporary economies. Technopreneurs provide online infrastructure for knowledge- and innovation-based economies. The development of technopreneurs has grown to be a significant strategic strategy to value generation and issue solutions. By supporting the creation of new, superior business models and economic growth, encouraging the emergence of technopreneurs could increase global economic competitiveness (Adeoti, 2019). The next topic will discuss how the rise of technopreneurs may encourage small-scale farmers to incorporate digital technology in their AVCs.

3.4.1 The Development of Technopreneurs to promote digital AVCs

Technology has a significant impact on how creative processes in business and society are shaped. Technology boosts business productivity and reduces the possibility of fraud in daily operations. Business growth is facilitated by maintaining records of operations and transactions effectively. It introduces a framework for business process automation to facilitate quick client connections and successful customer satisfaction (Gaur & Sharma, 2020). The nations with the strongest economies and most competitive markets have made substantial investments in technology (Adeoti, 2019).

The development of technopreneurs is based on science and technology and has a close relationship to entrepreneurial innovation (Fowosire et al., 2017). By rearranging the industrial components that produce profit, entrepreneurship creates new value (Adeoti, 2019). Digital technologies are essential to one of the most significant advancements in the globalisation of business and economic activity. New businesses that foster continual innovation and the development of sophisticated skills were born as a result. Technopreneurs combine entrepreneurship and technology to build a technologically advanced economic civilisation. A technopreneur is someone who re-launches a traditional business using technology artistry (Abbas, 2018; Gaur & Sharma, 2020).

By employing technology to introduce novel product concepts and services to the market, technopreneurs transform the existing economic structures (Debsin, 2021). When innovation is used to address significant economic difficulties using digital technology, this is known as organisational creativity. Technopreneurs are aware that science and technology are constantly evolving, inventive and taking uncharted directions (Siregar, 2019).

A technopreneur uses technology to achieve goals in business operations. They play a crucial role in the expansion and development of the economy, which depends on cutting-edge technology (Gaur & Sharma, 2020). Because there is a growing market demand for IT solutions, the idea of technopreneurship helps aspiring entrepreneurs succeed more (Debsin, 2021). To succeed, new technologies must be promoted and not simply appear. The development of new technologies depends on people thinking, reflecting, learning and applying their knowledge to both everyday issues and ones that formerly seemed insurmountable (Adeoti, 2019).

Technopreneurs are clever pioneers who develop novel technologies and have a tremendous aptitude for creativity, dynamism and unconventional thinking (Adeoti, 2019). Universities must therefore cultivate strategic thinkers with the required skills to succeed in this constantly changing global environment (Fowosire et al., 2017). Given the high risk and fantastic prospects, the government should be aggressive in offering venture capital-style investment to technopreneurs. Economic and innovation strategies should concentrate on utilising the global emerging digital economy and fostering an environment that will allow technopreneurs to succeed (Adeoti, 2019).

3.4.2 Innovative-driven Agripreneurship

An entrepreneur in the agriculture industry who develops an idea or vision into a new venture, or the expansion of an existing business is known as an "agripreneur." Many of these have an impact on markets and generate opportunities as well as threats. The importance of agripreneurs in boosting the economy and advancing rural areas is being recognised increasingly (GFRAS, 2022). There are many obstacles in the way of agriculture, but technology can remove some of them to the benefit of agriculture (Gaur & Sharma, 2020). Smaller farms now compete with large agricultural enterprises due to changes in agricultural markets around the world. For the local economy to avoid stagnation, farmers must upgrade and commercialise their production methods. Local cluster formation can help farmers adopt an agripreneurship model to boost collective productivity (IED, 2020).

Agripreneurs must not only concentrate on production but also approach the international market with a system that is in line with the AVCs. Local farmers can build alternative AVCs using digital platforms, bringing together different parties to enhance the value of the crops. This can create a more effective, fruitful and competitive connection between farmers, processors and markets (IED, 2020). The government must put national priorities in place for this digital agriculture revolution if it hopes to have a beneficial influence. Industry 4.0 is revolutionising international relations and commercial exchange, which has implications for the region (Siregar, 2019).

Agripreneurship improves quality and value at various points throughout the value chain to produce better financial outcomes. Digital marketing offers chances to attract a wider range of customers. To train farmers to become creative agripreneurs, it is necessary to build and improve rural centres that support entrepreneurship (IED, 2020). This will lead us next to examine existing digital technology in AVCs frameworks that innovate inclusive Industry 4.0. This will assist in the development of a framework to implement digital technology adoption in AVCs of small-scale farmers in South Africa that creates opportunities for technopreneurs and agripreneurs.

3.5 Existing digital technology adoption in AVC frameworks

Frameworks already in existence make it easier to embrace digital AVC platforms that can be utilised to develop strong innovation ecosystems with governance guidelines so that platform users can benefit from one another (Constantinides et al., 2018). Frameworks for the deliberate deployment of digital AVCs to improve small-scale farmers' livelihoods are related to this (GSMA, 2018). As a result, this section will briefly cover some of the frameworks from existing literature that can help in creating such a framework.

3.5.1 *E-agriculture framework in Kenya*

A single point of access for adopting digital technology is covered by the e-agriculture framework put forth by Awuor et al. (2016). It suggests that all stakeholders should contribute to the model's creation, discouraging middlemen. Information retrieval, machine learning and a data centre are included in the modules. The data centre hosts, organises, processes and keeps track of the acquired data.

To enhance the data centre, machine algorithms extract information from diverse sources that is pertinent to farmers, and an information retrieval module gets data from the data centre. A management layer, a data layer that builds and maintains a data centre, and an information access layer that satisfies information needs are all included in the framework governance structure (Awuor et al., 2016).

3.5.2 *Digital Innovation Hubs*

As a tool for commerce, standards, traceability and integrity, digital technology can close the information gap in AVCs (OECD, 2019). By bringing research and practice closer together, Digital Innovation Hubs (DIHs) employ digital platforms to catalyse the innovation process using a network of competency centres (EIP-AGRI, 2017). The Diffusion of Innovation (DOI) paradigm, which comprises a collection of ideas to describe how people and organisations adopt new digital technology policies and practices, is in line with this. Digital inventions can be adopted more quickly and widely by using the principles of diffusion of innovation (Dearing & Cox, 2018).

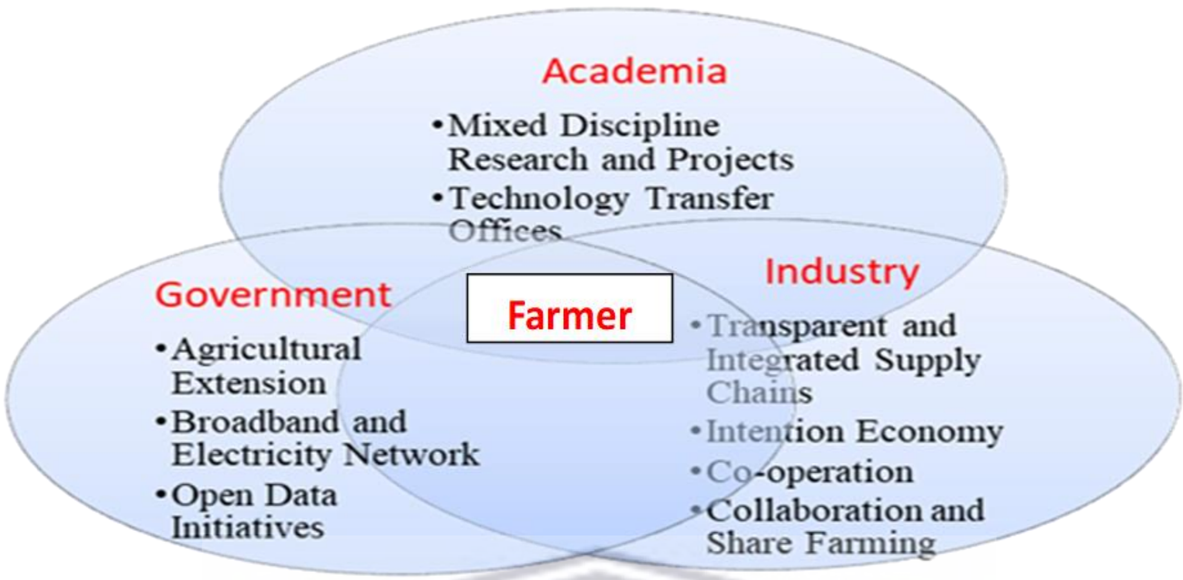


Figure 3-2: Digital Innovation Hubs (DIHs). (Source: Adapted from EIP-AGRI, 2017)

Figure 3-2 shows that DIHs are farmer-focused rather than technology-focused and have a solid business strategy DIHs assist existing businesses or new business owners in growing their enterprises through the use of digital technologies. The mainstay of the operations, Competence centres provide infrastructure, resources and technological expertise. Many forms of help are available during the stages of conception, development and manufacturing. DIHs use a direct, practical and "hands-on" approach (EIP-AGRI, 2017).

3.5.3 The Agro-Food Sustainability Knowledge Hub model

Small farms and agri-food Small and medium-sized businesses (SMEs) are connected to the urban market through a community-based approach. Distribution, creation of value and consumption are all connected. This improves an area's ecology, economics and society by fostering existing relationships or creating new ones (Manikas et al., 2019). The full AVC of the agricultural commodity is covered by the vertical integration business model. Margin is extracted along the whole AVC, thanks to the size, integration and logistical advantages of the business model (Amadeo & Rasur, 2022).

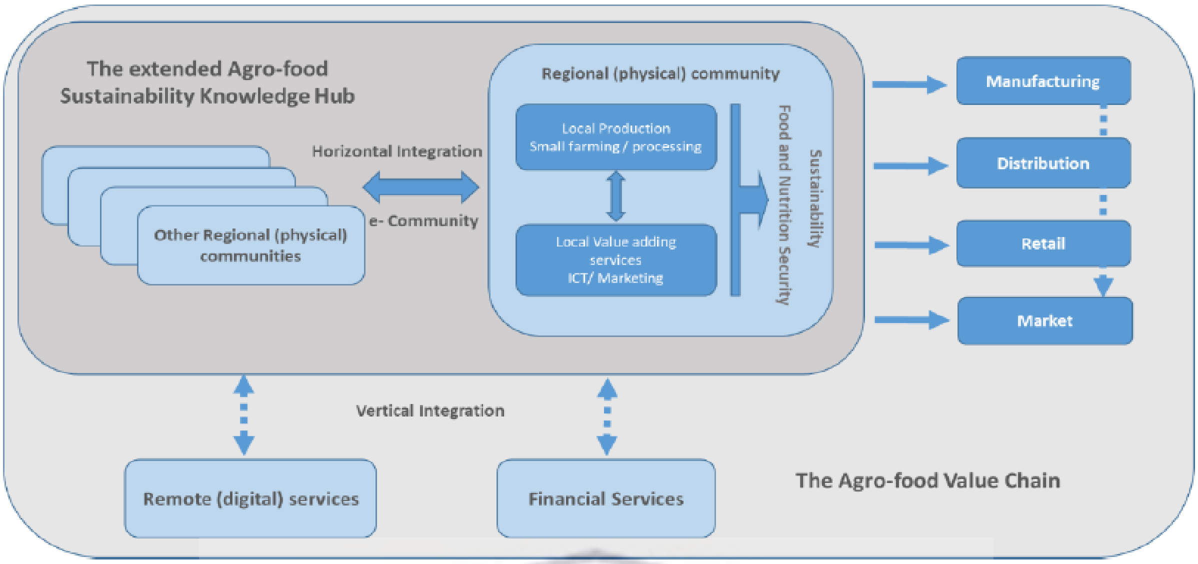


Figure 3-3: A community-based Agro-Food Knowledge Hub. (Source: Manikas et al., 2019)

The Corporate Social Responsibility (CSR) and Sustainable Supply Chain Management (SSCM) concepts and guidelines serve as the foundation for the Agro-Food Sustainability Knowledge Hub (Agro-Food) model in Figure 3-3. (SSCM). SMEs can grow sustainably inside established AVCs. These institutional, operational and strategic initiatives give agricultural SMEs the chance to also market their products and generate value through alternative, sustainable channels (Manikas et al., 2019).

This fits the description of Carroll's pyramid of CSR, which is influenced by academic proliferation, institutionalisation, globalisation and reconciliation with profitability. The four sorts of obligations include being financially successful, abiding by rules and regulations, acting morally and responsibly to prevent harm, being a good corporate citizen by supporting charitable causes and being ethically responsible (Carroll, 2016).

A hierarchy of horizontally integrated communities with a local, regional, national or international scope is considered by the Agro-Food hub in Figure 3-3. Farms within a region, multiple local towns, or a combination of the two make up a regional community. Local communities, regional communities, farms or any combination of these form the foundation of a nation. One type of local or regional community is a cooperative. Sectoral industries or farmer groups are two examples of national communities. One organisation operating on a worldwide scale is fair trade (Manikas et al., 2019).

The concept incorporates a framework based on principles that emphasise economies of scale in the logistics and marketing processes, while a sustainability approach expands the possibilities for local food access. The aforementioned frameworks can help with the creation of a framework for digital technology adoption in AVCs of small-scale farmers. However, it is critical to understand how South African government policies could impact the design. This prevents structure duplication and fosters trust between farmers and the community. As a result, the discussion of policies that may affect the implementation of this framework follows.

3.6 National policies that influence the adoption of digital technology in AVC of small-scale farmers in South Africa

The Agricultural Policy Action Plan (APAP) proposes suitable solutions based on the analysis of AVCs as economic growth drivers identified by the New Growth Path (NGP). The National Industrial Policy Framework, the National Development Plan and the Agricultural Policy Action Plan are all aligned to translate high-level responses into actionable initiatives (DAFF, 2016). The NDP puts forth a complex strategy for agricultural growth and claims that agriculture and agri-processing can completely change the South African economy. The NDP recommends boosting exports and putting more emphasis on regional economic integration (NAHF, 2017). The government must offer farmers all-encompassing support in order to achieve this.

The 2018 Comprehensive Producer Development Support Policy (PCPDS) directs and controls how producers are given support services. Through participative methods, the policy emphasises the obligations of organisations that deliver effective and efficient extension and advisory services (DAFF, 2018). Knowing the development requirements of small-scale farmers and knowing how to participate locally are crucial as agricultural advances, including how digital technologies are implemented (Agri-Symposium, 2019). The NDP suggests creating a network of innovation hubs inside a district municipality to boost funding for agricultural research and innovative technology (DRDLR, 2015). Agriculture technologies must be economical and contribute to reducing post-harvest losses (DAFF, 2018).

Future digital skills are being developed in collaboration with stakeholders under the iKamva National E-Skills Institute (iNeSI) Bill from the Department of Telecommunications (Government Gazette, Vol. 629, November 8, 2017, No. 41233). The bill creates iNeSI and collaborative laboratories for knowledge generation, training and coordination (Ungerer et al., 2018). This study proposes that to boost growth in agriculture-economic outputs, the government should collaborate with higher institutions and support strategic programmes that build digital skills and capacities. The nation must evaluate and put into practice what has worked to accomplish this. Sharing information offers the chance to address pressing problems facing AVCs more effectively. A framework for digital technology adoption in AVCs is defined and suggested in the section that follows.

3.7 Towards a framework for the adoption of a digital AVC

Since the introduction of technology in agriculture is a relatively recent phenomena, it is critical to identify the proper institutions that either exist or must be established. To avoid duplication of effort, it is crucial to identify key individuals, organisations and technological infrastructure that might improve collaboration and participation. The first subsection lists the institutions that already exist or that need to be established. It then examines the digital services that can be provided to small-scale farmers. The ICT design architecture required to provide these services is also described.

3.7.1 Institutional information of the framework

A different understanding of the structures and plans of organisations across all industries is made possible by Institutional theory. Organisations are characterised as local manifestations of larger institutions that abide by institutionalised rules to obtain legitimacy. This lessens uncertainty and makes an organisation's actions and activities more understandable (Berthod, 2016). In order to have a stable and lasting state, institutions must both adapt and remain stable (Sæbø, 2017). Institutionalisation is an evolutionary process, and its early stages are influenced by the organisational structure and operational modes already in place (Anandajayasekeram, 2011). Peters (2000) challenges static institutional explanations and points out the challenges of categorising institutional factors into simple nominal categories for measurement. To better comprehend the dynamics and create more effective institutional justifications for social and political occurrences, Peters (2000) suggests that it should be a continuous variable.

The digital technology adoption in AVCs framework for small-scale farmers institutionalisation aligns with the South African government's adoption of the District-Centred Development (DCD) paradigm. The concept ensures the greatest possible coordination and cooperation between the national, provincial and local levels of government. At the district level, it collaborates with civic society to expedite service delivery (DPME, 2019).

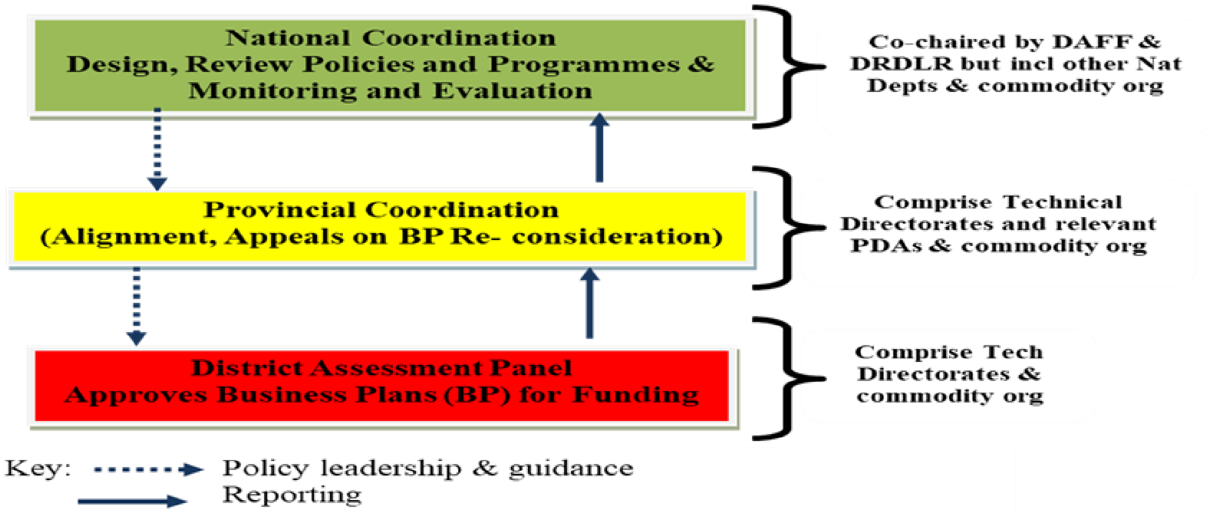


Figure 3-4: Institutional mechanism for implementing the Comprehensive Producer Development Support (PCPDS) policy. (Source: DAFF, 2018)

The DCD Model is in line with the institutional framework for putting the Comprehensive Producer Development Support (PCPDS) for agriculture development into practice shown in Figure 3-4. The PCPDS improves institutional procedures, harmonises producer categories and mainstreams vulnerable groups' participation. It is made up of a District Assessment Panel, a National Coordination Unit and Provincial Coordination Units.

The systems approach and participatory processes are highlighted for institutionalisation. A preliminary phase and an institutionalisation phase are both involved in this project (Anandajayasekeram, 2011). To win the trust of small-scale farmers, development initiatives, community involvement and cooperation must be implemented. Farmers must participate in the creation of technology solutions (Bayer, 2018). The DCD model boosts involvement and centres communities on service delivery to guarantee that development satisfies the demands of regional stakeholders (DPME, 2019).

Concerns for international development are entwined with issues of rural poverty, agricultural output and environmental preservation. Sustainable resource usage and poverty reduction must be promoted to manage the interconnections and interdependencies that add to this complexity (Campion, 2018). By concentrating governmental, corporate and non-profit investments in one district, the DCD model maximises impact. With a focus on regional economic growth and sustainability, it makes sure that urban and rural development complement one another (DPME, 2019).

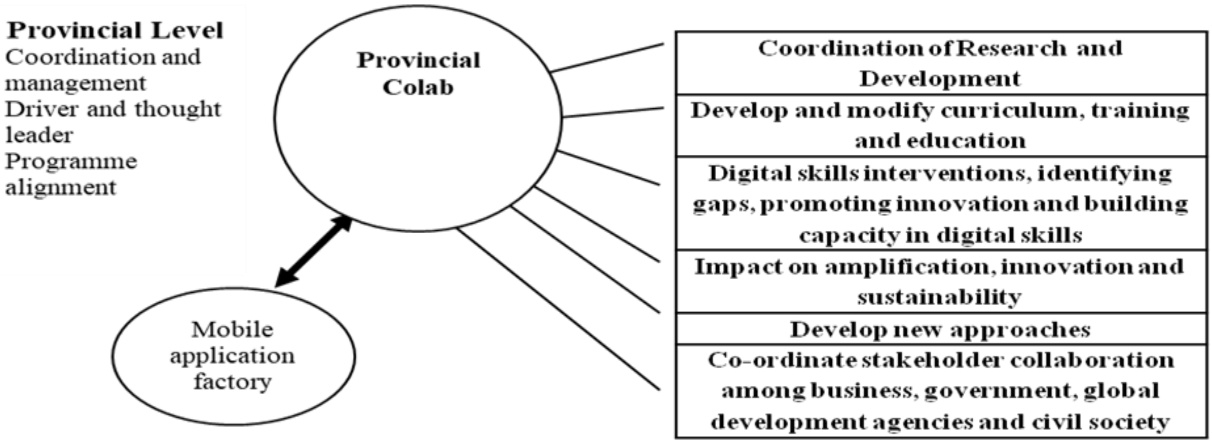


Figure 3-5: Provincial knowledge production and coordination Colab. (Source: Adapted from iNeSI, 2018)

A schematic of the iNeSI Provincial CoLabs, which directs theme areas and coordinates digital skills interventions in South Africa with national and developmental priorities, is shown in Figure 3-5. The iNeSI creates alliances that maximise impact, prevent duplication and make the most use of resources and infrastructure. Through research, iNeSI pinpoints digital gaps across industries, communities and location (iNeSI, 2018).

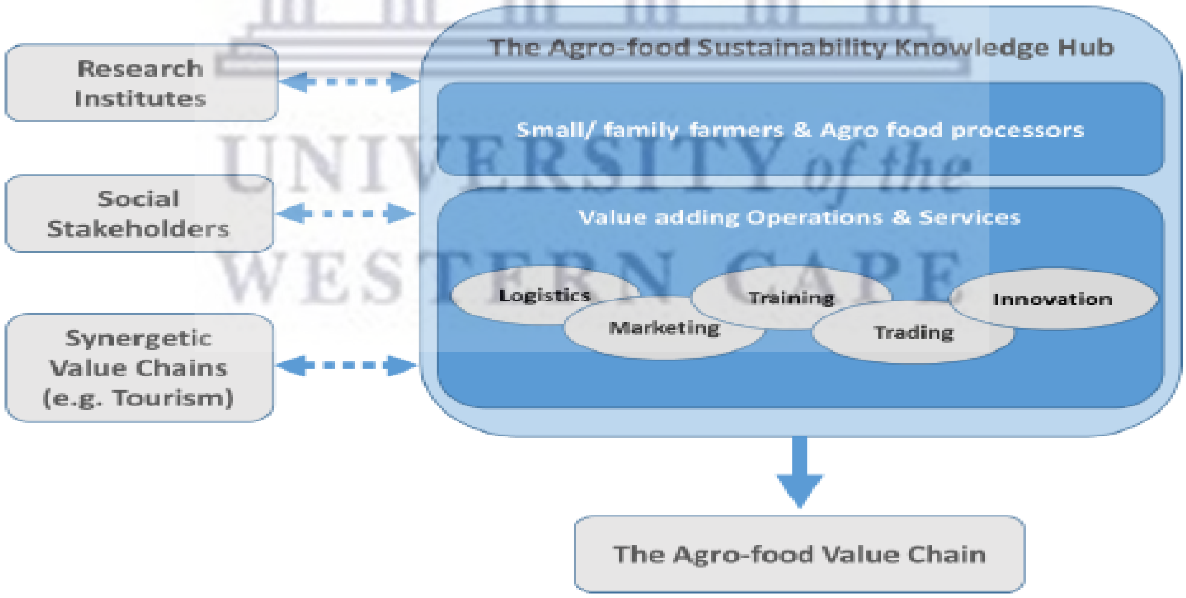


Figure 3-6: A holistic integrated Agro-Food Sustainability Knowledge Hub. (Source: Manikas et al., 2019)

The Agro-Food Hub in Figure 3-6 enables prospects for possible synergies among agricultural SMEs with services, including logistics, marketing, training, trade and innovation by using vertical integration to provide alternative sustainable channels of distribution. Farmers can reduce logistical expenses by integrating warehouse, transportation and infrastructure expenditures (Manikas et al., 2019).

The DCD model prioritises local procurement of services and goods to foster local entrepreneurship, support it and promote an atmosphere that is conducive to economic development (DPME, 2019). Similarly, the Agro-Food Hub serves as a knowledge broker, fostering enduring ties amongst AVC actors. As a result, AVC stakeholders become more competitive, sustainable and responsible (Manikas et al., 2019).

After discussing the institution that had influenced the development of the framework and identifying the roles of different stakeholders, the digital services needed to be developed for small-scale farmers are suggested in the following subsection.

3.7.2 Digital services suggested for developing small-scale farmers

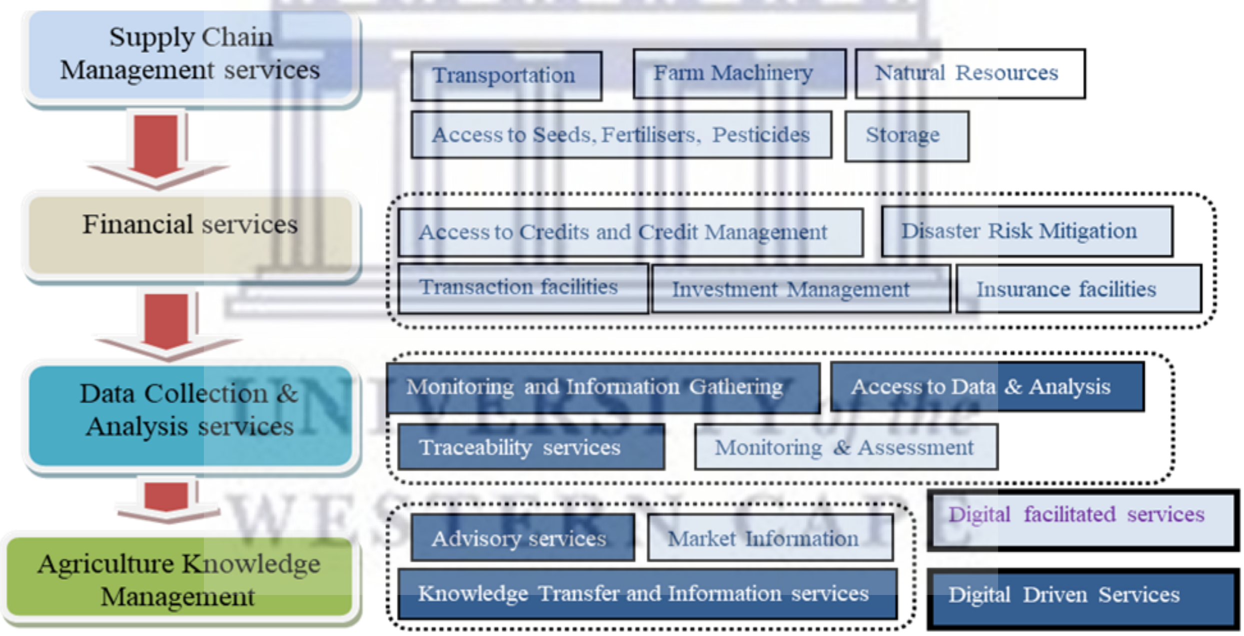


Figure 3-7: Agriculture sector cluster of digital services. (Source: Adapted from FAO & ITU, 2016)

Digital tools that enhance communication amongst AVCs are causing a new agricultural revolution (Campion, 2018). Value can be created through a variety of interactions amongst AVC actors thanks to a digital platform (Constantinides et al., 2018). To better manage, intervene, optimise and forecast occurrences, a farming data plan is used to monitor and assess them. Data from tracking and tracing is often used to bargain for improved market access (Maru et al., 2018).

The various digitally assisted and digitally driven services offered by the agriculture sector are depicted in Figure 3-7. Scalable payment methods and digital markets for market data are made possible by technology (FAO & ITU, 2016). It primarily focuses on the activities of businesses in the following sectors: telecommunications, digital services, software and IT consulting, hardware production, information services, platform economy, gig economy and sharing economy (Boateng et al., 2017).

Good Agriculture Practices (GAP) and electronic pest surveillance systems are linked to the traceability and tracking of agrochemical movement (FAO & ITU, 2016). The digital services must be supported by an ICT design architecture, which is covered in the next subsection.

3.7.3 ICT design architecture

The Technical Organisation Environment (TOE) paradigm, according to Baker (2011), is broadly applicable and was used to explain technological advances in a variety of industrial, national and cultural contexts in the agriculture sector. The TOE has demonstrated that environmental, organisational and technological factors all influence how quickly people adopt new technologies. As a result, the debate over whether society shapes technology or vice versa fails to provide a full understanding of technological evolution and the key variables influencing it (Salazar & Holbrook, 2008). The TOE framework is used for empirical study to understand the adoption of innovation in organisations and for inter-organisational adoption when new technologies are introduced (Baker, 2011).

The difficulty lies in the fact that institutional theory has typically focused on stability, yet technology is frequently linked to quick, sometimes disruptive changes in society and organisations. The study must understand these events that economic-rationalist frameworks do not adequately describe (Sæbø, 2017). ADMIT (Architecture Design [or Development] Methodology for Information Technology) can therefore be used as a decision-making tool for methodically creating a robust architecture employing design forces and strategies, as well as elements of the lifecycle processes. This technique outlines an architecture development lifecycle, including its stages and management procedures. Along with other frameworks like TOE, institutional theory, and actor-network theory, this study suggests for this to be employed.

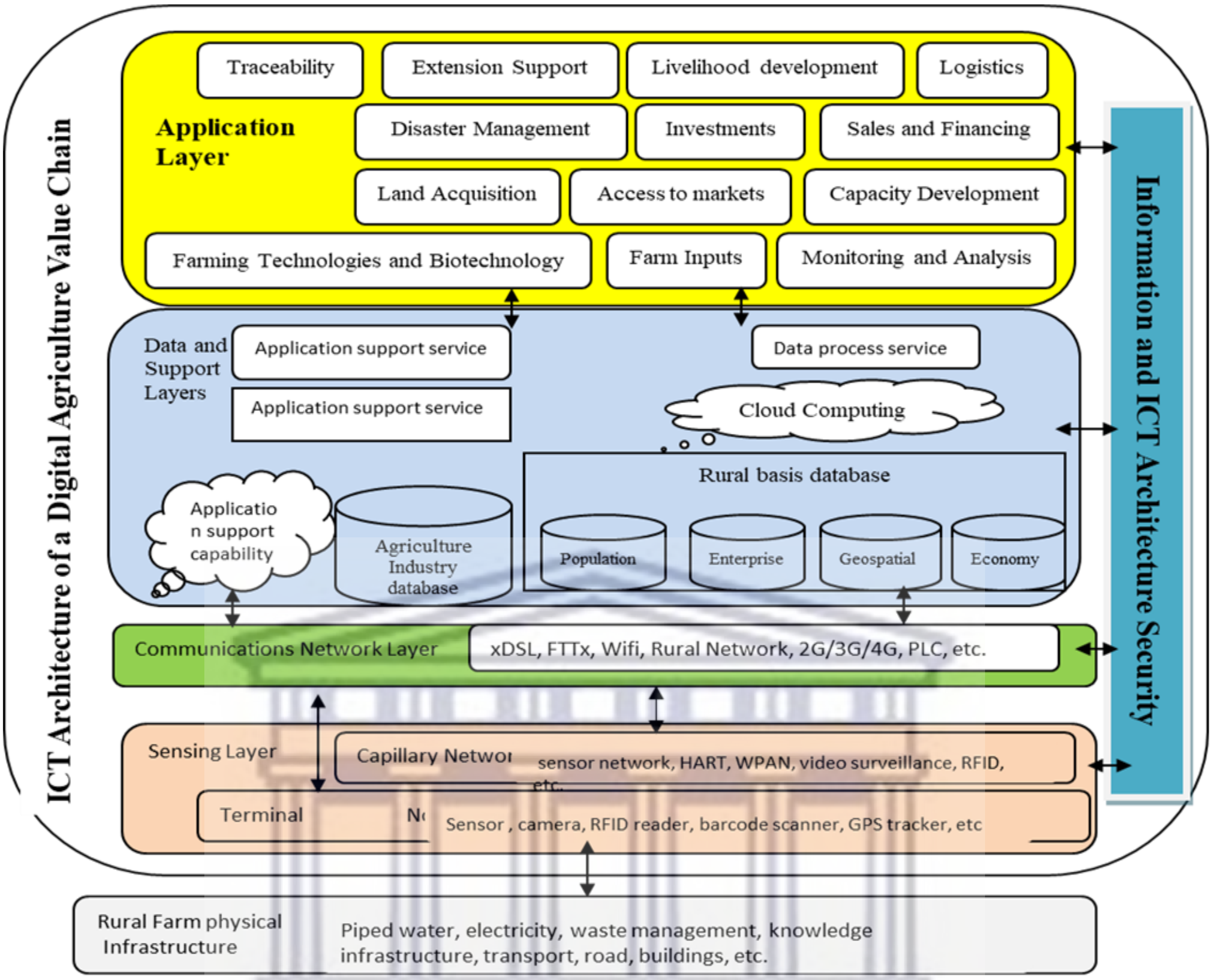


Figure 3-8: Architecture for a Digital Agriculture Value Chain. (Source: ITU & FAO, 2016)

The various ICT design architecture layers that can enable a digital AVC platform are depicted in Figure 3-8. Mobile phones and other IoT devices that support machine communication have direct internet connections. Sensing, communications networks, data and support, as well as application layers, are the various layers.

The sensing layer gathers information from the system's surroundings in order to recognise and react to diverse environmental stimuli. The communications network layer offers wireless broadband network coverage for the entire district, as well as internet access for other districts and global internet transmission. Data is transported between stakeholders and centralised servers in data centres using the data layer (ITU & FAO, 2016).

A digital AVC must be trustworthy, secure and resilient to vulnerabilities. This encompasses malicious software, political activism, accidental harm and natural catastrophes. The technical basis of the entire system is the security infrastructure. It offers security features like identity management, key security, disaster recovery and emergency monitoring (ITU & FAO, 2016).

Information facilitation and data sharing must have adequate safeguards of information and protection of intellectual property rights (Kanoktanaporn et al., 2019). The application layer service diverse requirements and information needs enable automated decision-making and alerts to the digital AVC (ITU & FAO, 2016). Research and development are required to demonstrate and validate the viability and reliability of the new technology (Campion, 2018). As a result, the discussion in the following section centres on how crucial it is to make use of a digital AVC to support training, research and innovation.

3.7.4 Research, innovation, and training support in digital AVCs

The information gained via research, the capacity to apply that knowledge to the creation of useful goods and services, and the capability to bring those goods and services to market through commercialisation, communication and service provision are the three essential components of innovation (Anandajayasekeram, 2011). Small-scale farmers and gender-sensitive research and development should be the primary drivers of innovative systems in the agriculture industry (DAFF, 2018). The DOI principles can be used to promote technology adoption in AVCs.

Innovation is the process by which an invention is productively employed financially. The four actions that make up innovation are creation, realisation, commercialisation and adoption. The invention may include original concepts, items, processes or other items created by individuals, scientists or by fusing knowledge from several sectors (Anandajayasekeram, 2011). When new verified technologies are developed, the research community should immediately promote their availability, advantages and integration (Ungerer et al., 2018).

The four factors of autonomy, flexibility, complexity and coherence are what determine how institutionalised a structure is. This dictates the changes that structures must undergo to survive and have an impact on their surroundings (Peters, 2000). Training many important stakeholders is one of institutionalisation's primary objectives, as is getting academic institutions ready to internalise training and curriculum development (Anandajayasekeram, 2011).

The opportunity for digital technology to continue to support and impact advances in farming is created by the requirement for the agriculture sector to boost output with fewer resources

(Ungerer et al., 2018). AVCs are being examined more closely due to worries about food safety and sustainable agriculture (Kanoktanaporn et al., 2019). Global recognition of the significance of small-scale farmers in developing markets and more cooperation in Africa could result in greater integration across AVCs (Ungerer et al., 2018).

To respond to changes in the regulatory environment and market demands, the agriculture sector primarily relies on research. As research continues to be the primary source of innovation, the government must fund it (DAFF, 2018). According to Bencherki (2017), the actor-network theory concept is made up of a variety of different people and objects, and for one actor to act, many others must also act. Since awareness of connectivity generates a great amount of uncertainty, it is important to comprehend the social and digital structures that technology creates (Lezaun, 2017). This study used actor-network analysis to examine the relationships between political players, individuals, groups and institutions in the agriculture sector by looking at the connections between them (Elder-Vass, 2019). The next section discusses the properties of the proposed digital agriculture value chain framework to improve small-scale farmers' agriculture-value chains in South Africa.

3.8 Properties of the Proposed Digital Agriculture Value Chain Framework

This study thus proposes a framework for implementing a digital AVC as shown in Figure 3-9 that uses the institutional arrangement in Figure 3-10, centred around District Agro-Food Sustainable Knowledge Hubs (DASKHs), supported by Provincial Agriculture Digital Innovation Hubs (PADIHs), and enabled by the ICT architecture in Figure 3-8 that can provide the digital services in Figure 3-7. The structure of the framework consists of a Foundation layer, Management layer, Data layer and Information Access layer.

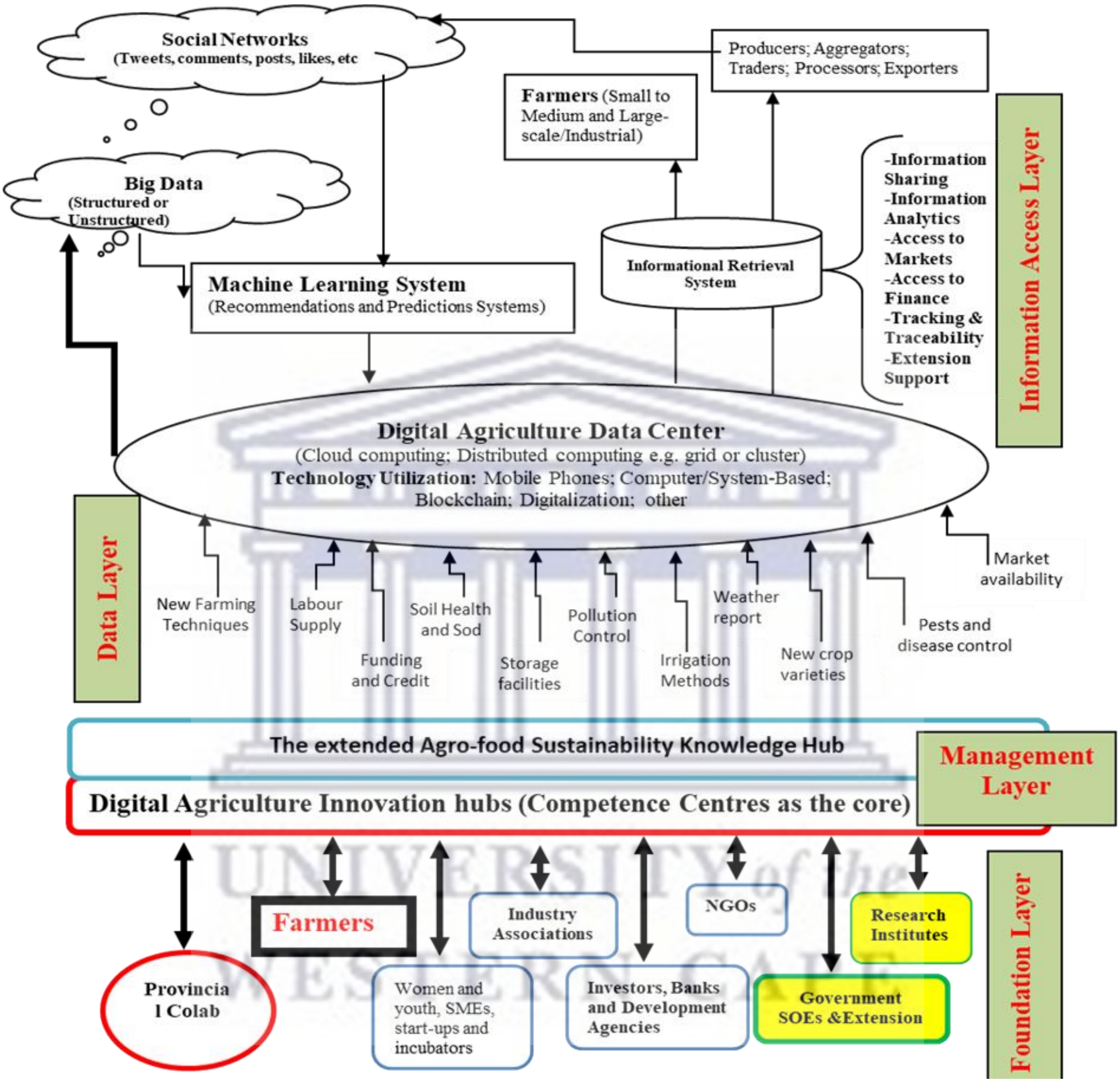


Figure 3-9: Proposed Framework for the adoption of a Digital AVC. (Source: Adapted from Awuor et al., 2016; Manikas et al., 2019; iNeSI, 2018; EIP-AGRI, 2017)

3.8.1 Foundation layer:

The Foundation Layers are represented by National and Provincial stakeholders such as Farmers, Industry associations, NGOs, Investors, Banks, Development Agencies, Women, Youth, SMEs, Start-ups, Incubators, Research Institutes, State Owned Enterprises and extension services (Manikas et al., 2019). This layer represents all agricultural stakeholders, identifying their contributions, areas of interest and clusters for coordination. It aims to achieve high agricultural productivity by fostering consensus among stakeholders (Awuor et al., 2016).

3.8.2 Management layer: Properties of the Institutions of the Proposed Framework

Through improved collaboration and the creation of a consortium or board of trustees, the second layer of the framework seeks to coordinate and integrate stakeholder roles in order to raise agricultural productivity (Awuor et al., 2016). This study thus proposes a framework for implementing a digital AVC as shown in Figure 3-9 that uses the institutional arrangement in Figure 3-10, centred around District Agro-Food Sustainable Knowledge Hubs (DASKHs), supported by Provincial Agriculture Digital Innovation Hubs (PADIHs), and enabled by the ICT architecture in Figure 3-8 that can provide the digital services in Figure 3-7. The structure of the framework consists of a Foundation layer, Management layer, Data layer and Information Access layer.

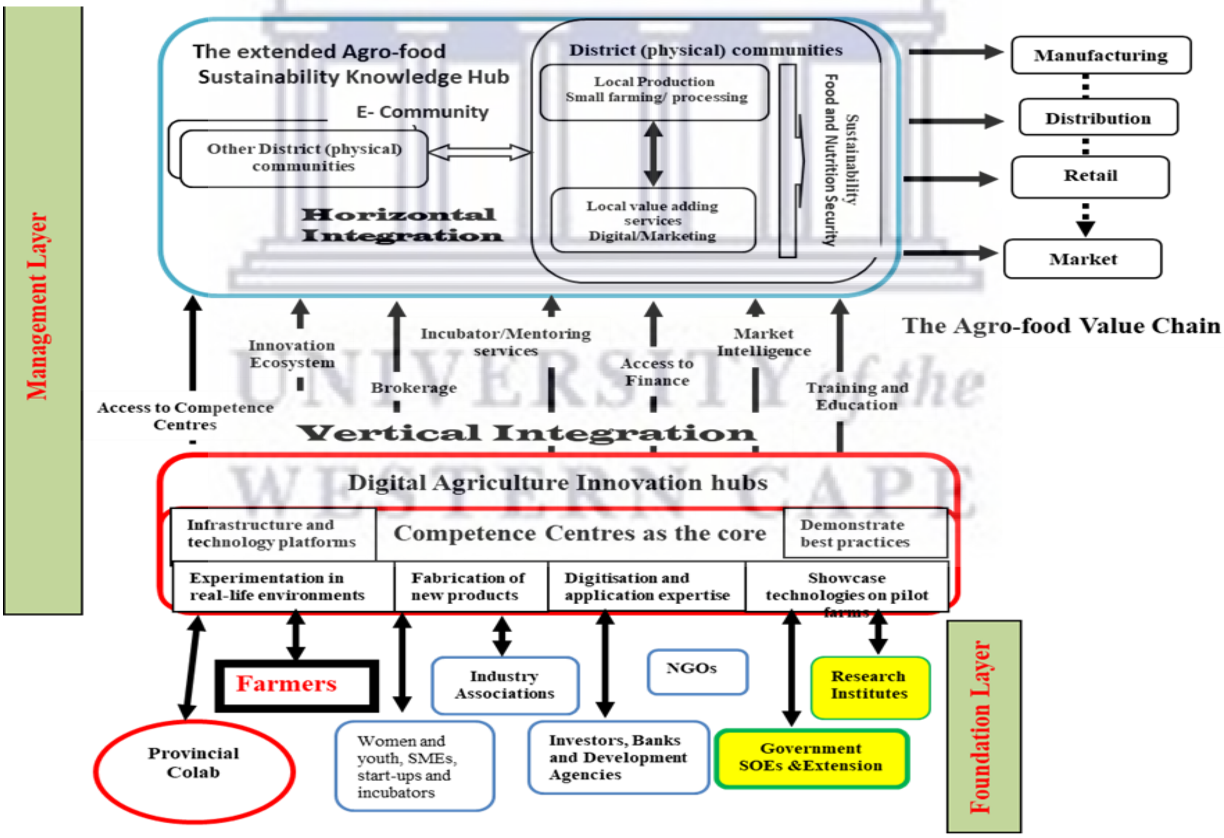


Figure 3-10: Institutional arrangement (Management layer) for a digital AVC. (Source: Adapted from Manikas et al., 2019; iNeSI, 2018; EIP-AGRI, 2017)

This layer makes sure that each person's interests are met, promoting both overall productivity and personal output. It is essential for the framework's viability and usability because it gives farmers a single point of access to agricultural information. Game theory is used to manage the layer, which leads to the creation of a consortium (Awuor et al., 2016). The management layer is formed by PADIHs and DASKHs which also in Figure 3-10 depicts the institutional setup of such a framework. Provincial PADIHs work with district-level DASKHs in the AVC to build an innovation ecosystem and support SME agribusinesses in going digital. Vertical integration, the DOI principles and Carroll's CSR pyramid are consequently all included into the institutional design. The PCPDS and DCD models are supported, and it works with iNeSI.

PADIHs offer digital services to the agricultural sector, and small-scale farmers in particular. As a result, PADIHs can offer incubator and mentorship services to fledgling businesses. Access to infrastructure and technological platforms is provided via Competence Centres, which are the foundation of PADIHs. Competence centres of PADIHs offer access to infrastructure and technological platforms by utilising the DOI principles. This encourages innovation through experimentation, the creation of new goods and the presentation of technological best practices (EIP-AGRI, 2017).

As a driving force and thought leader, iNeSI engages with the provincial Colab to increase knowledge development and improve digital skills interventions (iNeSI, 2018). As a result, this study suggests the establishment of Provincial Agriculture Digital Innovation Hubs (PADIHs), should cooperate closely with iNeSI through Colabs, depicted in Figure 3-5.

The support required to persuade small-scale farmers to embrace technology is determined using a customised strategy based on an assessment of farmers' resources and capabilities (Campion, 2018). Each of the nine provinces has an iNeSI distributive model to conduct digital skills training (iNeSI, 2018). Small-scale farmers may realise the true added value of technologies through collaboration with DIHs, which can help them to choose which technologies to invest in, when to invest and how much to invest (EIP-AGRI, 2017).

This study proposes the establishment of District Agro-Food Sustainable Knowledge Hubs (DASKHs) to foster grassroots innovation when small-scale farmers adopt digital technologies in AVCs. Through "distributive justice" (the allocation of value along the AVC) and "procedural justice (management of processes and relationships)," power is shared between small-scale farmer stakeholders. To achieve supply chain "justice," DASKHs let small-scale farmers participate in decision-making, which fully unleashes their potential (Manikas et al., 2019). Thus, DASKHs matches with Carroll's CSR pyramid's four pillars of being economically successful, abiding by rules and regulations, being ethically responsible, and acting in a way that is just and fair to prevent harm.

3.8.3 Data layer

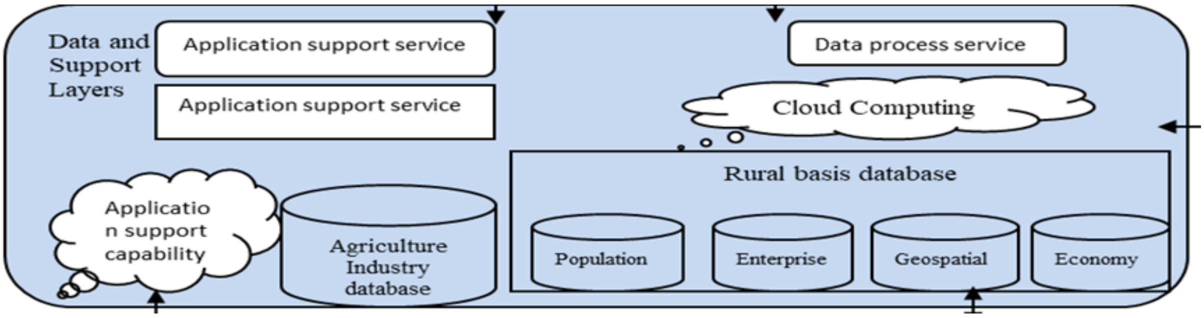


Figure 3-11:Data Layer adapted from Architecture for a Digital Agriculture Value Chain. (Source: ITU & FAO, 2016)

The Data layer as part of the digital architecture is a virtual layer where data can be stored, processed and sent. In computer software, a data layer of a computer programme offers streamlined access to data kept in storage of any form, like an entity-relational database. Since data is only collected once, using a data layer enables you to standardise data definitions. This makes it quicker to collect data and then distribute it via a data layer (ITU & FAO, 2016). The layer aims to develop and maintain a data centre that collects, processes and stores data from all stakeholders, aiming to meet the information needs of small-scale farmers. Stakeholders often develop applications to meet small-scale farmers' needs, but this can be tedious and time-consuming. The layer provides a single information access point for stakeholders, sharing resources with farmers using a single information centre. It also ensures secure data storage, authenticates access, integrates heterogeneous data and fusions stakeholders to support comprehensive information needs. The layer represents all agricultural stakeholders, identifying their contributions and areas of interest, grouping them into clusters for coordination and reaching consensus on the need for cooperation to support agriculture. Each stakeholder is expected to contribute to achieving high agricultural productivity (Awuor et al., 2016).

3.8.4 Information Access layer

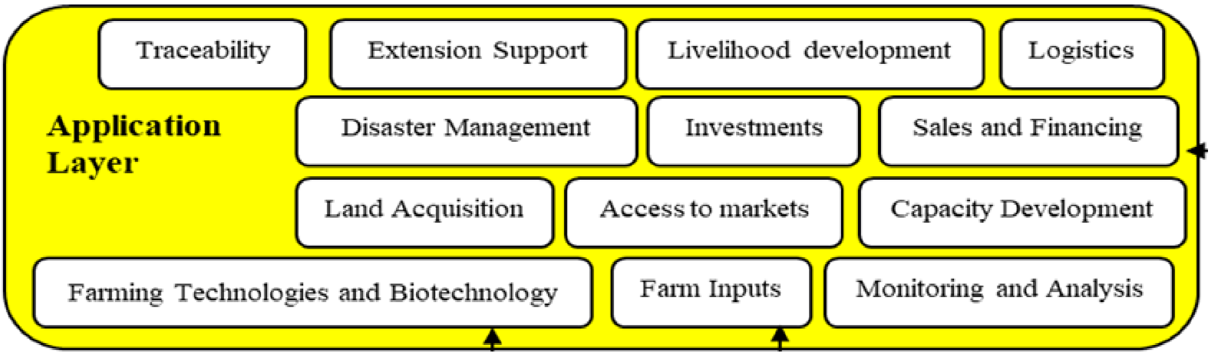


Figure 3-12: Information Access layer adapted Architecture for a Digital Agriculture Value Chain. (Source: ITU & FAO, 2016)

The upper layer of the framework empowers small-scale farmers to retrieve information from a data centre, tailored to their needs based on culture, gender, literacy, digital divide and urgency. It offers various services like language translation, speech synthesis, automated SMS, calls and dedicated websites for agriculture. The system automatically sends farmers urgent information via SMS or calls, enabling them to access and share relevant information. It incorporates social networks, big data and human computing modules to empower farmers to use big data and the Internet for decision-making. Farmers can also communicate on social media platforms (Awuor et al., 2016).

The Information Access Layer (IAL) as part of the digital architecture presents information to the user and tools in an easy-to-find and understand manner. A great deal of helpful data may be found in every programme. However, users, report developers and decision-makers frequently find it challenging to immediately extract helpful information from this application data. The IAL's main goal is to organise the application's information so that it is simpler to discover and utilise. The Information Analysis Layer (IAL) stands between application data and information collection and analysis tools like report tools, data warehouses, and Online Analytical Processing (OLAP). With the use of the OLAP computing approach, users can quickly and arbitrarily extract and query data in order to analyse it from various angles. OLAP business intelligence queries are useful for a variety of planning tasks, including trend analysis, financial reporting, sales forecasting and budgeting (ITU & FAO, 2016).

The modules of proposed Information Access Layer are as follows:

- **eAgriculture data center:** Data hosts manage and store data from various sources, utilising tools like cloud computing, distributed computing techniques, machine learning, human computing, and micro-tasks for relational querying and information retrieval.
- **Machine learning module:** Machine learning algorithms enrich agricultural data centres by extracting farmer-relevant information from internet and social networks, updating concepts and providing timely information.
- **Social networks and Web 2.0 module:** Social networks revolutionise communication, replacing traditional methods like phone calls and texting. A framework for farmers collects and processes agricultural posts using machine learning, crowdsourcing and user feedback for improved user experience.
- **Information retrieval module:** The agricultural data centre has a proposed information retrieval system supporting farmers' queries and automatic information transmission. Currently, systems use call agents, text translation tools and video tutorials

(Awuor et al., 2016).

3.9 Using RABIT Assessment tool to validate the Proposed Digital AVC Framework

Small-scale agriculture tends to be the predominant economic sector in rural areas of developing countries. Attempts to increase agricultural output and outcomes are hampered and can be reversed by short-term shocks and long-term trends such as climate change. Considering the current sustainable development paradigm, small-scale farmers need to build their resilience in order to handle this (Hanson & Heeks, 2020). Resilience Assessment Benchmarking and Impact Toolkit (RABIT) was previously used in previous projects to measure and visualise two different aspects of resilience: firstly, the overall resilience of the two communities (in the Costa Rican capital, San Jose; and in the Mount Elgon coffee farming region of Uganda), and secondly, the “e-resilience” of these communities; that is, the contribution that digital technology was making to resilience (Ospina et al., 2016).

Given their growing role in rural livelihoods, digital technologies are a key part of resilience-building. A systematic literature review by Hanson and Heeks (2020) established the impact of digital technologies adoption in agriculture. Measuring resilience using the RABIT reported evidence that suggests digital technology adoption mostly strengthens rural resilience.

Small-scale farmers' resilience is related to their capacity to handle external shocks and trends. Ospina and Heeks (2016) identified knowledge gaps in the conceptualisation and empirical application of resilience and how D4D might support resilience in a developing country's field research. To properly field test and validate new digital technology adoption frameworks that generate resilience, RABIT gives the IS discipline new insights. The proposed framework's potential to support small-scale farmers' resilience was validated by this study.

The framework for using digital technology in small-scale farmers' digital AVCs goes beyond technology adoption to create simultaneous and complementary adjustments in resource provision, as well as the growth of rural institutions and social structures. The goal is to better incorporate agency plus power and to provide clarity on the limits and indicators of the resilience system (Hanson & Heeks, 2020). RABIT is used to validate the proposed framework's effects on small-scale farmers. Small-scale farmers have been proven to possess various resilience attributes. Through inductive creation and explanation, a better conceptual framework is produced. It investigates the significance of the motives of specific small-scale farmers, the supplementary resources needed to make digital technology support resilience and the function of more general systemic factors, like institutions and structural interactions.

3.9.1 A Critical Reflection of RABIT 's use for this study

For this study, we use to benchmark small-scale farmers' resilience by assessing the strengthening of the impact of development interventions such as the adoption of digital technologies to build the resilience of small-scale farmers to climate change. In earlier studies, the RABIT was applied through surveys and interviews to measure both community resilience and "e-resilience" (contribution of digital technology to community resilience). This conceptualisation and operationalisation of resilience also consider how the use of Digital for Development (D4D) in underdeveloped nations helps build resilience (Ospina, 2018).

The analysis carried out in this study required the use of the RABIT. It created a clear conceptual connection between small-scale farmer resilience and the digital AVC framework, which made it possible to extract and analyse data using the techniques covered in the next chapter. It is backed by a comprehensive examination of small farmers' use of digital AVCs. This contributed to a deeper comprehension of the resiliency of small-scale farmers and served as the structure for the investigation. The operationalisation of the suggested framework relied heavily on the resilience qualities and associated markers, and most of the evidence fits well into the already-existing attributes, indicating a high level of completeness.

RABIT makes it possible to quantify resilience baselines and the effect of development initiatives, notably the adoption of digital technology on resilience. It emphasises community resilience in low-income areas. RABIT defines nine attributes, or sub-properties of resilience that can be used to understand it. The three main pillars of resilience are learning self-organisation and robustness. Redundancy, speed, scale, diversity, adaptability and equality are six secondary resilience enablers. Small-scale farmers will be more resilient if they are stronger (Ospina, 2018). As a reference to the data collection and analysis that follows in, the attributes of small-scale farmers' resilience and their key markers are summarised in Table 3-3.

Table 3-3: Benefits of new digital technologies across different players in AVCs

Resilience Attribute	Definition	Key Markers/Characteristics
FOUNDATIONAL ATTRIBUTES OF SMALL-SCALE FARMER RESILIENCE		
Robustness	The small-scale farmer's capacity to keep its traits and performance despite environmental shocks and changes.	Physical readiness, institutional strength, multi-level governance and networking
Self-Organisation	The capacity of a small-scale farmer to change its operations and procedures on their initiative and unaffected by outside forces in the face of an external disturbance.	Social networks; local leadership; consensus-building; participation; collaboration and consensus-building.
Learning	The small-scale farmers' ability to generate feedback, learn or create knowledge and improve skills and capacities. This is strongly correlated with small-scale farmers 'capacity for experimentation, discovery and innovation	Reflective thinking, New and Traditional Knowledge and Capacity Building
ENABLING ATTRIBUTES OF SMALL-SCALE FARMER RESILIENCE		
Redundancy	The degree to which resources and institutions used by small-scale farmers may be replaced, for instance, in the event of a disruption or decline.	Resource Substitutability; Functional Overlaps and Interdependency; and Resource Spareness
Rapidity	The speed at which small-scale farmers can access or mobilise assets to effectively accomplish goals.	Rapid resource mobilisation, resource assessment, and resource access
Scale	The variety of resources and facilities a small-scale farmer can use to successfully combat, recover from, or adjust to the consequences of disturbances	Multi-level Networks; Resource Access and (intra/inter) Partnerships; and Cross-level Interactions
Diversity and Flexibility	The capacity of the small-scale farmer to follow many paths with the resources at their disposal while allowing them to innovate and take advantage of any chances that may arise from change.	Diverse Pathways/Emerging Opportunities; Flexible Decision-Making; Innovation Backbone
Equality	The extent to which the small-scale farmer offers equal access to rights, resources and opportunities to its members.	Strengthened skills and closing of gaps; inclusivity; openness and accountability

(Source: Adapted from Ospina et al., 2016)

3.9.2 Key Points of Using Resilience Assessment Benchmarking and Impact Toolkit (RABIT)

- Understanding resilience is crucial for designing, implementing and evaluating development interventions, as it enables small-scale farmers to adapt and transform, based on six enabling traits and three foundational attributes.
- RABIT offers three options for adding value: understanding small-scale farmer resiliency, gauging baseline resilience and determining strategic goals for development interventions at farmer, district, provincial and national levels.
- The study compared nine resilience qualities in small-scale farmers using RABIT, focusing on their perceived strengths in robustness and self-organisation. However, they also identified limitations in their robustness, such as insecurity, infrastructure and emergency readiness.
- The findings suggest three improvements to development interventions: identifying current resilience strengths, providing a snapshot of priority issues and identifying weaknesses for strengthening small-scale farmer resilience.
- Digital technologies significantly impact small-scale farmers' AVC through self-organisation, diversity, flexibility and rapidity. They identify new opportunities and features like robustness, redundancy, equality, size and learning

(Ospina et al., 2016).

The table below shows how the Proposed Digital Agriculture Value Chain Framework Layers might be able to positively influence the RABBIT attributes.

Table 3-4: Linking Key RABIT attributes to proposed framework

RABBIT Atributes	Proposed Digital Agriculture Value Chain Framework Layers			
	Foundation	Management	Data	Information
self-organization	x	X	x	x
diversity	x	X		x
flexibility	x	X		x
rapidity.	x	X		x
robustness		X	x	x
redundancy		X		x
equality		X		x
scale		X	x	x
learning		X	x	x

3.10 Chapter Summary

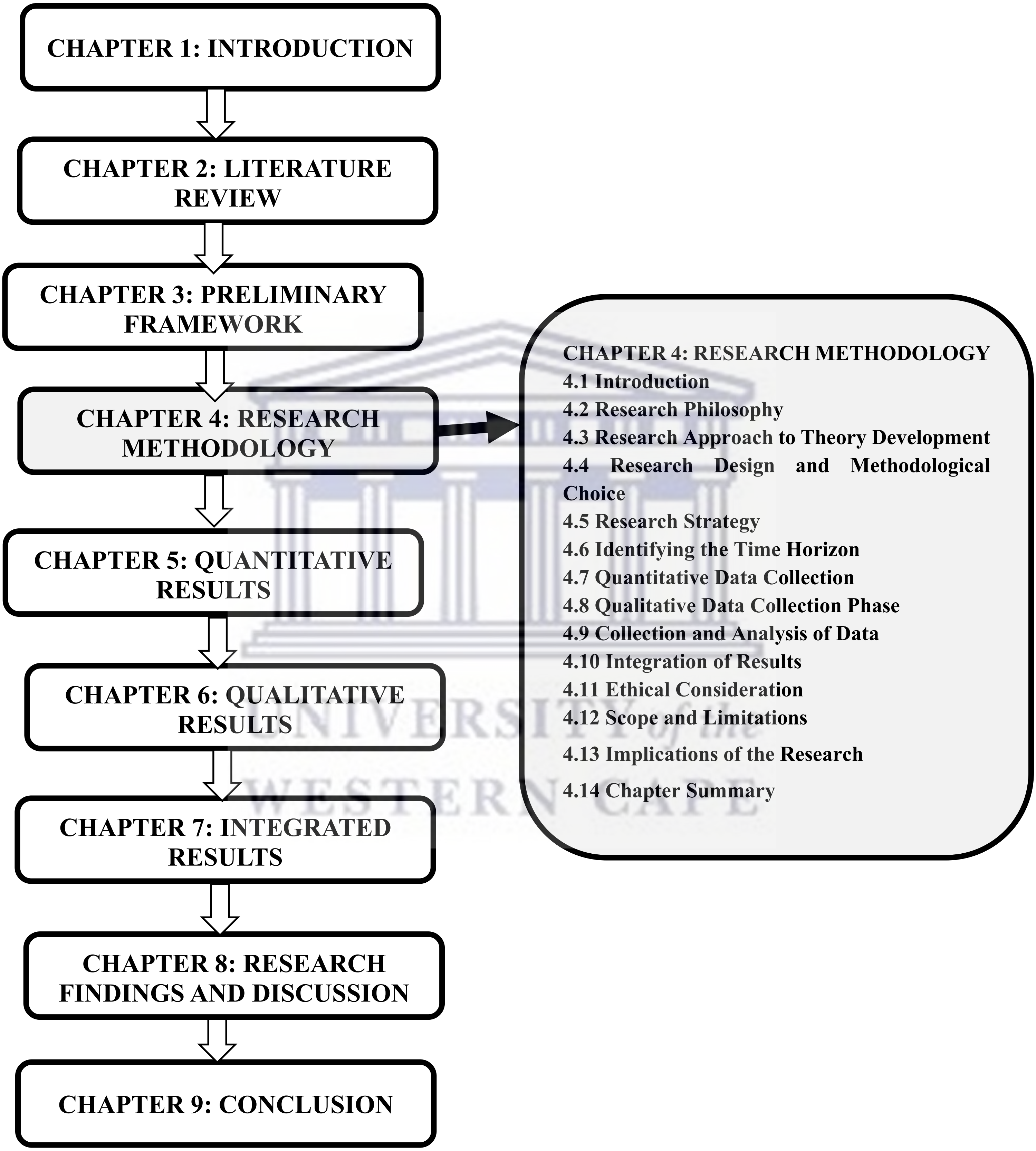
South Africa must address the digital gap in the agriculture industry by supporting small farmers and promoting sustainable practices in line with Carroll's CSR pyramid (Ungerer et al., 2018). This includes considering environmental, societal, and ethical considerations in addition to product quality. Encouraging vertical integration and collaborations is crucial for achieving collective sustainability.

The research highlights the positive impact of digital technology adoption on small-scale farmers' AVCs, transforming them into an integrated operational model for sustainability. This enhances competitive advantage through planned collaboration and joint application of expertise and resources.

Government and financial sector should support agri-entrepreneurs and AgTech proposals that develop small-scale farmers. They collaborate in digital AVCs by providing advisory and analytical data services. (Ungerer et al., 2018). New Public Private Partnerships (PPP) models are needed to provide long-term digital services to small-scale farmers. District-level DASKHs can improve sustainability and reach a global audience while maintaining farmers' autonomy. PADIHs offer digital services, brokerage, finance, market data, training, education, and mentorship to SMEs, focusing on SMEs. They also provide mentorship services for new start-ups.

This study explores the adoption of digital AVCs in South Africa, focusing on the use of DASKHs, PADIHs, and vertical integration. The framework recommends DOI principles, CSR, and district, provincial, and national levels impact. The research methodology for validating the preliminary implementation framework is discussed in the next chapter.

CHAPTER 4: DIAGRAMMATIC OVERVIEW



4 Chapter 4: Research Methodology

4.1 Introduction

The previous chapter proposed a conceptual framework to implement digital Agriculture Value Chains (AVCs) for small-scale farmers in South Africa. The framework identified components that could unmask strategies and policies to assist with digital technology adoption in AVCs of small-scale farmers. This chapter discusses the research methodology for improving and validating the preliminary digital technology adoption in the AVCs framework.

The purpose of the study design is to describe the research technique, focal areas for data collecting, tools and the data analysis process. It ensures that a study goal is achieved while considering certain factors, including resource and time constraints (Mouton & Marais, 1998). This study makes use of the research onion, which offers a series of procedures to adhere to while developing a research plan (Saunders et al., 2019; Bryman, 2015).

All research involves philosophy in action, and if philosophy is not understood, research outcomes will be murky or incorrect (Hassan et al., 2018). To describe how a community of scientists thought, Thomas Kuhn first used the term "paradigm" as a system of thought in the academic community in 1962. (Mertens, 2012). Researchers' conceptions of what constitutes knowledge and truth influence what they believe, think, and assume about society. In social science, the term "paradigm" is used to describe a worldview pertaining to individuals' commitments, beliefs, values, techniques and viewpoints throughout a subject (Kawulich, 2012). A set of presumptions and convictions known as philosophy are applied when learning and studying in any field (Saunders et al., 2019).

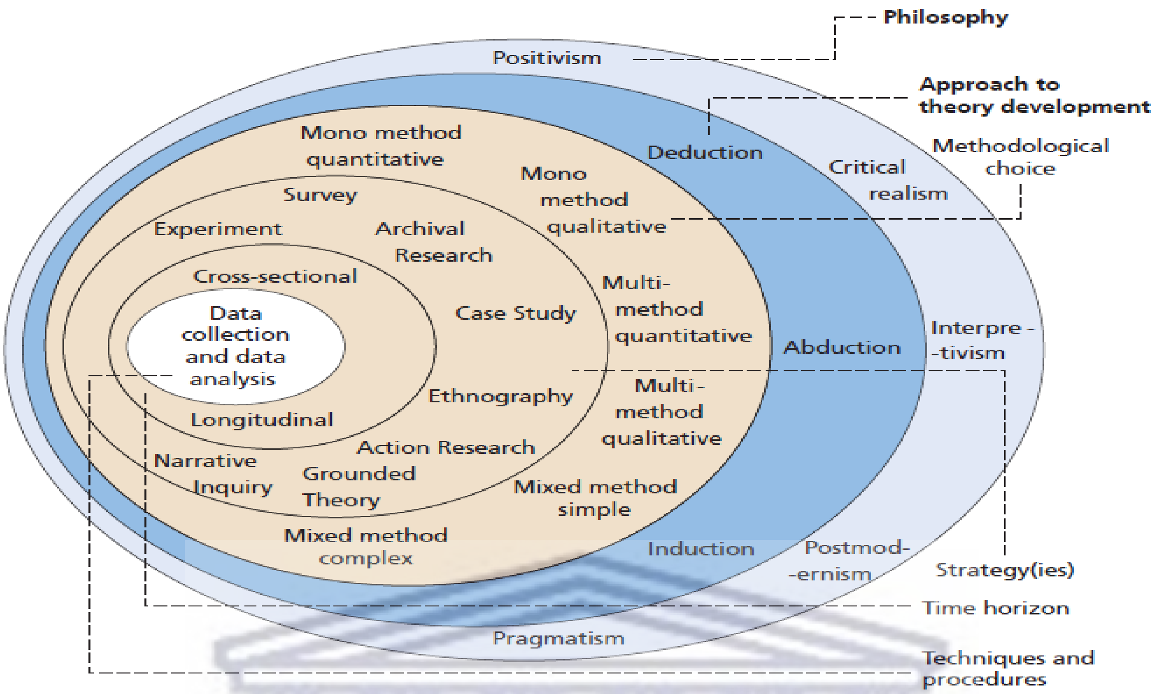


Figure 4-1: The Research Onion. (Source: Saunders et al., 2019)

The research onion in Figure 4-1 suggests a set of steps followed when creating the research strategy used for this study (Saunders et al., 2019; Bryman, 2015). A research design gives the researcher the ability to manage all risks and compromises, ensuring that the research project's findings are reliable (Mouton, 1998). The procedures employed during research are referred to as research methods, and research methodology is a manner of systematically solving the research topic (Kothari, 2004).

In line with the research onion, this chapter discusses the design of the research methodology to complete the experimentation portion of the study. This chapter is structured as follows: section 4.2 presents the research philosophy, section 4.3 describes the research approach and section 4.4 discusses the research design and methodological choice. Section 4.5 discusses the research strategy, section 4.6 discusses identifying the time horizon, section 4.7 discusses quantitative data collection, section 4.8 discusses qualitative data collection, section 4.9 collection and analysis of data, section 4.10 discusses integrating the results, section 4.11 discusses ethical consideration, section 4.12 discusses scope and limitations, 4.13 discusses implications of the research and section 4.14 ends the chapter with a summary. The next section discusses the philosophical paradigm of the research which provides the basis of assumptions to guide the conduct of the research.

4.2 Research Philosophy

When gaining knowledge and conducting a study in any particular discipline, a set of assumptions and beliefs known as philosophy is employed (Saunders et al., 2019). According to Hassan et al. (2018), every research is philosophy in action, and if philosophy is not grasped, research findings will be ambiguous or inaccurate

Table 4-1: Philosophical questions researchers need to understand

• *What am I researching?*	• *What does it mean to know?*
• *What is knowledge?*	• *How can I create knowledge?*
• *What is truth and is it important?*	• *What exists and can be described?*
• *Are the consequences of my research acceptable?*	• *Is it right for me to ask the question?*
• *How can I communicate my insights?*	• *Who am I?*
• *Who is my audience, and who are the people using IS?*	

(Source: Adapted from Hassan et al., 2018)

By understanding the philosophical issues in Table 4-1, researchers can enhance the calibre of their work and make sure it is accurate and insightful. When attempting to comprehend what Digital for Development (D4D) means, these queries may spark additional inquiries. Whether it also considers how people who do not utilise digital technologies are affected by them is another question (Hassan et al., 2018). The philosophical underpinnings of the terms "Digital" and "Development" and "4," which are the transformative processes that connect the two, should serve as the basis for an all-encompassing understanding of D4D. Given the extensive documentation, the ontological concerns of what "Digital" and "Development" are and how they relate to one another can be answered with ease.

However, there is not much literature on how the use of digital technologies promotes development (Sein et al., 2019). There is a need for more research to determine why digital development is successful in underdeveloped nations and for what reasons (Thapa & Omland, 2018). It is necessary to establish a procedure that may explain "why" a certain use of technology works and another one does not (Sein et al., 2019). The D4D philosophy is a new philosophical development that has implications for socioeconomic growth. Considering this, it is preferable to do D4D methodological research from a philosophical paradigm since it can highlight techniques that are more appropriate for conducting this kind of research (Lee et al., 2014). To do D4D research, scholars must have a solid foundation in information systems, social theory and philosophy. It will be necessary to approach this from a philosophical paradigm standpoint that is informed by systems information thinking and social theory (Lee, 2004).

The Transformation Emancipatory Paradigm (TEP) has been heavily utilised by academic scholars in recent years as a theoretical framework for achieving social justice. This is a result of TEP's importance in the production of knowledge to study and develop underprivileged people. Since TEP is used by this study as the philosophical research paradigm, the primary goal of this section is to summarise and evaluate the literature on it and offer TEP as a paradigm for D4D research aimed at achieving digital justice.

This is accomplished by first analysing the main philosophical beliefs and methodological issues related to D4D, and then by synthesising the works of researchers who looked into the TEP philosophical phenomenon. The significance of the work of Mertens in understanding TEP as a research paradigm is emphasised. The study concludes by arguing that TEP is relevant to D4D research and demonstrates how it is connected to efforts to achieve digital justice for South Africa's small-scale farmers.

4.2.1 Using TEP to implement D4D research in South Africa

When conducting research, a topic is first chosen, and then a paradigm that embodies the framework of assumptions and principles for looking into that topic is found. The type of social phenomena under investigation is identified, and their objectivity or subjectivity is determined (Kawulich, 2012). A new D4D paradigm's impact is linked to a restructuring of the relationships between competitive and cooperative logic (Heeks, 2020b). The method through which knowledge about social reality is obtained and spread, such as whether a person is conditioned by their surroundings or whether they create their environment, establishes the basis of that knowledge (Kawulich, 2012).

Understanding the idea of a digital society, which is the current modern state of the information society, requires a comprehensive study of the D4D phenomena (Khazieva et al., 2018). Digital technologies have been linked to a competitive logic of capitalism, competitive markets and hierarchical state-citizen relations in the economic and political spheres of developing countries. The D4D paradigm, on the other hand, is occasionally connected to expanding situations and opportunities for alternative politics and economics based on cooperative logic (Heeks, 2020b). Understanding the paradigm that guides your research is the first step in developing the approach for a study (Kawulich, 2012). Thus, the idea of a paradigm as a theoretical foundation is explained next.

4.2.2 What is a paradigm?

Paradigms specify assumptions about reality, knowledge, ethics and systematic investigation in terms of philosophical frameworks. Digital equality will not be achieved if the digital divide is only viewed through digital inclusion. There are also undesirable effects of digital integration (Heeks, 2020). It is crucial to fundamentally challenge dominance and overthrow the status quo in order to close the digital divide through inclusion and justice in the digital age.

Thomas Kuhn introduced the term "paradigm" as a conceptual framework in the academic world in 1962 to characterise how a community of scientists thought (Mertens, 2012). Researchers think, believe and make assumptions about society based on their perceptions of what constitutes truth and knowledge. A paradigm is a term used in social science to express a worldview concerning people's commitments, beliefs, values, methodologies and perspectives throughout a discipline (Kawulich, 2012). Differences in the research community's assumptions on nature's axiology, ontology, epistemology and methodology are clarified by paradigms (Mertens, 2012; 2010).

- Axiology explores how ethics and value systems impact our perception of truth and research challenges, highlighting the importance of balancing these factors.
- Presumptions regarding reality, both verifiable and socially constructed realities, are made by ontology.
- Epistemology investigates authentic, valid and acceptable knowledge, determining its veracity through communication methods and determining whether beliefs constitute knowledge or require hard evidence.
- These paradigmatic aspects assist us in deciding how to investigate it and the strategies and methodology employed to meet the research goals.

(Saunders et al., 2019; Kawulich, 2012).

Regulation and radical change viewpoints are ideological components of research paradigms, influencing researchers' political or economic stance on social contexts. Regulation focuses on human behaviour and societies, while radical change advocates for status quo continuation (Saunders et al., 2019). Researchers investigate political explanations with a radical change-philosophical orientation, seeking to disrupt the current order and promote conflict, contradiction and exploitation, challenging dominance and exploitation (Mertens & McLaughlin, 2004).

The paradigm applied in this study is the Transformative Emancipatory Paradigm (TEP) which is consistent with the radical change perspective. According to TEP, many factors go into defining what is real, including race, gender, ethnicity, culture, politics and the economy. It reckons that values are important because they differ from culture to culture (Saunders et al., 2019). TEP instructs researchers on how to identify and articulate their beliefs regarding ethics, reality, knowledge and methodology in order to advance human rights and social justice (Mertens, 2012).

In terms of philosophical frameworks, paradigms define presumptions on reality, knowledge, ethics and methodical enquiry. Merely bridging the digital divide through digital inclusion will not achieve digital equality. There is a need to also investigate negative digital integration (Heeks, 2020). To bridge the digital divide through inclusion and justice in the digital age, it is imperative to fundamentally challenge dominance and topple the status quo. According to this study, D4D implementation and research are in line with thoughts on radical change. Acquiring information about this social reality is the goal in order to counter it with a pro-equity perspective for successful digital inclusion.

TEP emphasises the necessity of altering the current situation with an emphasis on matters of power, politics, dominance and oppression. The competitive logic of capitalism, competitive markets and hierarchical state-citizen relations are still deeply ingrained in the South African economy. As a D4D paradigm, TEP is linked to alternative, cooperatively-based economics and politics. TEP may make it possible for us to significantly reduce the inequities that now exist between mostly white commercial farmers and mostly black small-scale farmers in South Africa. The application of TEP as a philosophical paradigm based on cooperative logic to carry out D4D initiatives for small-scale farmers in South Africa is thus examined further.

4.2.3 The Transformative Emancipatory Paradigm (TEP)

The philosophical foundation for TEP starts with an axiological presumption. This enables the researcher to draw conclusions about the nature of reality, knowledge and methodical enquiry that are consistent with this ethical position. Reality has several facets because it is connected to many social power structures. These various perceptions of reality lead to an epistemological presumption that involves communities in research to confront oppressive systems in ways that are respectful of their cultures (Mertens, 2012). The community is involved in the creation and implementation of methods. Discussions about the pertinent socio-historical backgrounds and power dynamics in the community help draw conclusions about the research results. As a result, objectives relating to social justice serve as guidance for the study process (Shannon-Baker, 2016).

The emancipation and transformation of disadvantaged populations through collective action is a common concept found in several philosophies and theories that have an impact on TEP (Mertens, 2009). Neo-Marxism, feminist theories, critical racial theory, Freirean theory, participatory theory, emancipatory theory, postcolonial theory, indigenous theory, queer theory, disability theories and action research all contribute to the intellectual foundation of TEP (Saunders et al., 2019; Kawulich, 2012; Mertens, 2009; Romm, 2015).

TEP enables individuals to liberate themselves by dispelling misconceptions in order to drastically alter society (Kawulich, 2012). The idea that the ruling class, which controls the means of production of knowledge, also controls the mental production of information is aided by Marxism, one of the influential philosophies. This explains why research paradigms in the North dominate information produced in the South and unavoidably sustain the dominant class's supremacy over other social classes (Romm, 2015).

Every scientific theory begins with a stance that is occasionally correct or incorrect, and the theory that discloses illusions informs the truth (Kawulich, 2012). When working for social justice with marginalised groups that encounter prejudice and oppression, TEP is applicable. This paradigm can be used to understand the power structures that sustain social injustices and to help marginalised groups effect good social and personal change (Mertens, 2010; Shannon-Baker, 2016). TEP centres its study on the lives and experiences of underrepresented populations (Mertens & McLaughlin, 2004). This makes it possible for academics to respect marginalised groups' cultural traditions while learning from their indigenous knowledge to provide wisdom for social transformation (Mertens, 2009).

TEP is an expansion of the paradigm framework for social research that Guba and Lincoln created between 1994 and 2005. TEP is based on a modified version of the paradigms that Kuhn defined in 1996. The following is an explanation of each of the four philosophical presuppositions: axiology, ontology, epistemology and methodology (Mertens, 2009).

i. Axiology: Research is an ethical and political activity that requires scholars to adopt a position on values, allowing for objective analysis and recognising different opinions, unlike the interpretive paradigm.

ii. Ontology: Social reality is historically constrained and evolving, with facets visible and invisible, requiring exploration using theories and historical perspectives.

iii. Epistemology: Reliable information enhances people's lives and empowers them. True knowledge is influenced by collective meaning-making, encouraging behaviour that improves the quality of life. Both participants and researchers are transformed by the knowledge created from their perspectives.

iv. Methodology: Quantitative and qualitative methods empower individuals to transform society by destroying myths, illusions and false knowledge through participatory rural appraisal and action research designs.

(Mertens, 2009).

Researchers must question their commitment to the community where they are conducting their research ethically. Not only are they being critical of themselves, but also of the cultural blinders that prevent them from having a beneficial influence on the participants' lives (Mertens, 2007). By cultivating respectful connections with all stakeholders, including the powerful and the less powerful, TEP can assist researchers in gaining a deeper understanding of the complex difficulties facing South Africans (Mertens, 2012).

To make digital technology more accessible, inexpensive, and usable, the fight against the digital gap and for digital inclusion must continue. To prevent negative digital incorporation, digital equity must also be addressed (Heeks, 2020). As the paradigm works with those who lack access to social justice and those who are subjected to prejudice and oppression, TEP can help with the issue of digital equality.

TEP promotes the value perspective that spreads the notion that those who control the mental production of knowledge and ideas also control growth. This is clear in developing nations, demonstrating that D4D is linked to the logic of capitalism, competitive markets and hierarchical state-citizen relations (Heeks, 2020b).

TEP places a strong emphasis on the lives of oppressed groups and is pertinent to researching power relations to remedy social injustices. Thus, it can be applied to create "advantageous digital incorporations" that have a pro-equity emphasis. Inequality can be decreased by including marginalised small-scale farmers in systems of equal structural development (Heeks, 2020). Wherever they do their research, researchers must be morally upright and considerate of the participants' cultures. TEP can assist academics in better understanding the complicated issues facing South Africa so they may forge connections with all socially significant parties.

South Africa's socioeconomic problems, which are characterised by disparities, highlight the necessity for a D4D paradigm that provides prospects for alternative economics and politics based on cooperative logic (Heeks, 2020b). As a cooperative logic-based philosophical framework, TEP can offer a D4D research paradigm to offer alternative economics and politics. The need for a TEP as a philosophical framework for the D4D study of small-scale farmers in South Africa is thus discussed next.

4.2.4 TEP as a Philosophical framework for D4D research of small-scale farmers in South Africa

In terms of economic ownership, South Africa continues to be one of the nations with the greatest levels of inequality in the world. The effects of apartheid are still felt today. Inequality in income distribution, access to opportunities and regional inequities are examples of this. Rising unemployment because of the economy's stagnation has exacerbated inequality in South Africa (WID, 2020). Since 1994, the post-apartheid administrations' policies, strategic decisions and structural failings have led to an increase in inequality. Future fundamental reforms must be more robust and inclusive to provide opportunities for the part of the population on the margins (SAG, 2019).

By 2030, the South African government wants to restructure the agricultural industry to make it possible for black small-scale farmers to participate meaningfully in the AVCs, making them relevant (SAG, 2012). TEP can serve as a framework for research aimed at social and individual transformation. It enables scientists to ask research questions that go against the unjust status quo. Incorporating knowledge based on cultural perceptions and intuition gives us the chance to respond to disparities in what knowledge is (Mertens, 2017).

TEP offers several practical strategies for turning on transformative paradigmatic intentions to advance social justice. Researchers must be aware of their obligations and the potential repercussions of their research practices in South Africa (Romm, 2015). The recognition that social, political, cultural, economic, racial and ethnic values create and shape realities suggests that power and privilege are the key variables of which reality will be favoured in a study environment (Mertens, 2007). It is possible to expand the function of researchers in challenging conditions to boost their capacity to influence social change for the better.

In South Africa, Mertens employed TEP in 2016 to incorporate social transformation based on human rights and social justice into the research process. She concluded that community-based action research represented the best use of TEP in solving persistent, wicked challenges that researchers encounter. Mertens (2016) offered the following philosophical presumptions when looking into wicked issues in South Africa using TEP:

- Axiology: Collaborate with stakeholders, build purpose and adopt inclusive, diverse techniques in South Africa.
- Ontology: Dispels false belief that Native Africans are inferior to Europeans and require specific training.
- Epistemology: Social knowledge is built through connections and cultural understanding.
- Methodology: Transformative cyclical approaches combine M&E with participant-driven action for social change, promoting community involvement and empowerment and promoting social justice and rights.

(Mertens, 2012).

It is important to note that digital equity cannot be attained solely through digital inclusion; rather, it must also be protected from unfavourable digital integration. This fundamentally challenges dominance and challenges the status quo to close the digital gap. D4D research must be in line with thoughts on dramatic change. This will make it possible to incorporate a pro-equity orientation in the knowledge acquisition related to social reality.

As seen in Figure 4-1, TEP can be positioned within a Postmodernism Philosophical and Critical Realism perspective in the Onion. With a primary focus on themes of power, politics, dominance and oppression, TEP emphasises challenging the status quo. Alternative economics and politics based on cooperative logic are linked to TEP as a D4D paradigm. This has the potential to significantly reduce the disparities that currently exist in South Africa and are still reinforced by the logic of competition in capitalism, competitive markets and hierarchical relationships between the state and its citizens.

Using D4D, the transformative paradigm can be used to create research that could change the South African agricultural industry on an individual and societal level. It can help overcome the legacy of apartheid by creating governmental policies, tactics and mechanisms that make favourable digital incorporations possible. As a result, small-scale farmers will be able to engage actively in AVCs and help reduce disparities in the agricultural sector. Thus, guided by the research onion, the research approach to theory development is discussed next.

4.3 Research Approach to Theory Development

Deduction, induction and abduction are the three primary methods for developing theories. Deductive reasoning involves drawing conclusions based on a general premise or fact, while inductive reasoning constructs general hypotheses based on specific observations (Saunders et al., 2007).

4.3.1 Deductive Approach

Deduction leads to the development of a theory, a hypothesis (or hypotheses) and a research plan to test the hypothesis (Saunders et al., 2019). The deductive approach involves developing a basic theory and knowledge foundation, and then verifying specific research findings against it. (Kothari, 2004). Data gathering determines if observed occurrences align with expectations, ensuring the conclusion is true if the premises are true, and assessing claims or hypotheses related to established theories. Concepts are operationalised for quantitative measurement, requiring deductive generalisation and a suitable sample size (Saunders et al., 2007).

Deductive reasoning is the process of arriving at a conclusion about an instance based on a general premise or fact (Zikmund et al., 2013). The positivist approach, allowing hypotheses and statistical testing, is well-suited for deductive research, as it can be applied alongside qualitative research methods (Saunders et al., 2007).

4.3.2 Inductive Approach

Induction involves gathering data, analysing it and creating a new or changing theory using extra data to investigate phenomena, discover themes and explain patterns (Saunders et al., 2019). Inductive reasoning establishes broad claims based on observations, using well-known premises to arrive at unproven conclusions. Data collection helps identify themes, and patterns and develop a conceptual framework for theories (Mouton, 1998).

4.3.3 Abductive Approach

Abductive inference draws conclusions from known premises, generalising based on the interaction between specific and generic factors. Investigation involves identifying themes and patterns, testing in a conceptual framework, and generating new or changing existing ones. Abductive technique integrates deduction and induction, focusing on observing surprising facts and developing reasonable explanations. It is adaptable and useful for researchers from various perspectives (Saunders et al., 2019).

4.3.4 Research Approach for this study

To support developing small-scale farmers in agriculture-value chains, this project created a digital AVC framework. In order to further explain or examine the quantitative data, the use of an explanatory sequential mixed methods design required the acquisition of qualitative data after a quantitative phase. In the beginning, the project employed a survey of the literature to put up a working hypothesis and basic framework for D4D implementation in the AVCs of small-scale farmers.

To produce testable results, this study employed an abductive inference, using known premises. Through a review of the literature, a conceptual framework for investigating a phenomenon was created. This is determined by the interactions between the specific and the general. The previously identified patterns and themes were put to the test through further data collection. Where applicable, old theory was incorporated into new theory to alter the latter.

To enhance the initial framework, an inductive approach is used. Data were gathered and examined in the study's quantitative phase. Concepts were operationalised and quantitative data were gathered to explain causal links between variables using a highly structured process. To assure validity and reliability, it used controls and facilitated replication. It ensures that samples are chosen that are large enough to allow for generalisation.

To validate the revised framework created with the data gathered in the first quantitative phase, a round of qualitative interviews was undertaken. The goal of the exploratory follow-up is to validate the revised framework and contribute to the explanation or expansion of the first quantitative results. The gathering of qualitative data with a more adaptable structure allows for shifting the focus of the research as it goes along. This will help us understand the meanings that people give to the data that they observe to form generalisations.

Thematic Analysis using codes and themes helped us make sense by looking at patterns of meaning in the data set. The goal was to find out about the opinions, views and experiences of participants. Thematic Analysis is an exploratory process that aligns with the research aims and objectives to understand people's experiences, views and opinions (Braun & Clarke, 2006). This was used to validate the developed digital technology adoption in AVCs in the framework of small-scale farmers. Thus, the research design and methodological preference will be covered next.

4.4 Research Design and Methodological Choice

The research design summarises the study's methodology, and outlines techniques and steps for gathering and analysing data (Kothari, 2004). Different objectives drive the pursuit of research projects. These can be classified as explanatory, descriptive, exploratory or causal (Saunders et al., 2007; Zikmund et al., 2013).

During the planning of the research design, decide on the study's type, participants and experimental stimuli, as well as the primary and secondary data sources, such as surveys, observations or experiments (Mouton, 1998). The goal of research design is to develop a research project based on a research question and objectives. It takes periods, options and research methodologies into account (Kothari, 2004).

Scientists use knowledge and evidence to make unbiased judgements about the real world, analyse empirical data and forecast future events. They apply methods to support or refute preconceived notions and conduct exploratory studies to uncover new concepts (Zikmund et al., 2013).

4.4.1 Methodological Choice

Research methodology is a strategy for methodically addressing the research topic, while research methods are the techniques employed by the researcher while doing the research (Kothari, 2004). The mono-method, mixed-method and multi-method options are depicted in the research onion in Figure 4-1 (Saunders et al., 2007). The mono-method calls for employing just one type of research methodology. The mixed methods required the use of two research methodologies, typically combining a qualitative technique with a quantitative methodology. A larger variety of methods are used in the multi-method approach (Bryman, 2015).

Multiple approaches offer higher chances to respond to a study topic, assess how much can be trusted in the results and draw conclusions (Saunders et al., 2019; 2007). The main distinction between the mixed and multi-methods is that the former uses a combination of methodologies to produce a single dataset, while the latter is divided into various segments, each of which produces a different dataset (Flick, 2011).

The preference between qualitative research, which is typically linked with interpretivism, and quantitative research, which is typically connected with positivism, is based on the idea that the two are distinct from one another and do not compete. Both have advantages and disadvantages that can be used to balance one another (Tuli, 2005). Although most interpretive advocates oppose taking a relative stance, it is argued that this approach can be used for quantitative analysis to seek the truth. Truth claims based on ontology and epistemology can be accepted because truth is never finite (Sandberg, 2005).

D4D research methods are social and contextual, involving literature reviews, theories, questions, case sampling, data collection, analysis and writing findings. They aim to formulate general principles for uncertain outcomes (Bryman, 2015). It is best to use mixed methods to better understand and explain the linkages and dynamic qualities of the social world in which D4D interventions occur (Ospina & Heeks, 2016).

4.4.2 Mixed Methods Research

Mixed methods research is both a method and a methodology for conducting research that entails gathering, analysing and combining quantitative and qualitative data in a single study (Creswell, 2013). Mixed methods employ quantitative and qualitative data collection and analysis techniques and procedures concurrently (parallel) or sequentially (sequential), but not in combination (Saunders et al., 2007).

Mixed methods research is not necessarily superior to mono-method research (Bryman, 2015). Quantitative nor qualitative techniques and procedures predominate, quantitative data are analysed quantitatively, and qualitative data are analysed qualitatively (Saunders et al., 2007).

4.4.3 Mixed Methods Research Strengths

The advantage of using mixed methods is that triangulation is possible. Semi-structured group interviews, for example, may be a valuable way of triangulating data collected through other means, such as a questionnaire (Saunders et al., 2007). The researcher can benefit from the best of both worlds because it provides a comprehensive view of the phenomenon and compensates for the weaknesses of one method with the strengths of the other (Jokonya, 2016b).

Triangulation is a measurement technique that locates an object in space by relying on two known points to ‘‘triangulate’’ often to an unknown fixed point in that same space. The concept of triangulation is used for validating the veracity of research results. Alternatively, it can be used for the logical discussion of ideas and opinions to seek a more in-depth investigation to clarify research findings (Bryman, 2015).

4.4.4 Mixed Methods Digital for Development (D4D) Research

Traditional methods struggle to resolve wicked problems, but mixed methods can better understand complexity. These methods involve researchers from diverse groups, culturally appropriate participation, and policymakers in problem identification and documentation (Mertens, 2016).

Wisdom is crucial for human existence and can address global crises. Digital technologies are linked to wisdom discovery, creation, sharing and support. A new branch of wisdom management focuses on wisdom computing research and decision support systems (Ribeiro 2021). Mertens (2016) argues that the nature of research and interactions with the diverse constituencies affected by wicked problems must change to accommodate a more comprehensive understanding that is interdisciplinary and transdisciplinary.

It is best to use mixed methods for complex information systems research that has both social and natural characteristics (Jokonya, 2016b). Within a single study, both qualitative and quantitative methods are feasible and highly appropriate (Saunders et al., 2007). This can create a better understanding and explanation of the linkages and dynamic qualities of the social world in which digital development interventions occur (Ospina & Heeks, 2016).

4.4.5 Mixed Methods Research Purposes and Rationale

Some researchers prefer to use a mixed methods approach by taking advantage of the differences between quantitative and qualitative methods. Depending on the type of study and its methodological foundation, it may use this in a single research project. Mixed methods are used when quantitative and qualitative approaches are insufficient, yield different results, and provide more evidence, are preferred within a scholarly community, or mirror real-life situations (Saunders et al., 2007). The goal of mixed methods research for this study is to provide a better understanding of the research problem or issue than one method alone.

4.4.6 Sequential Explanatory Mixed Methods Design

Mixed methods are commonly used to compare quantitative and qualitative research findings or to use qualitative research to help explain quantitative findings (Creswell, 2013). Figure 4-2 depicts an explanatory sequential mixed methods design proposed as a methodology for developing an improved framework to implement digital technology adoption in AVCs of small-scale farmers in South Africa.

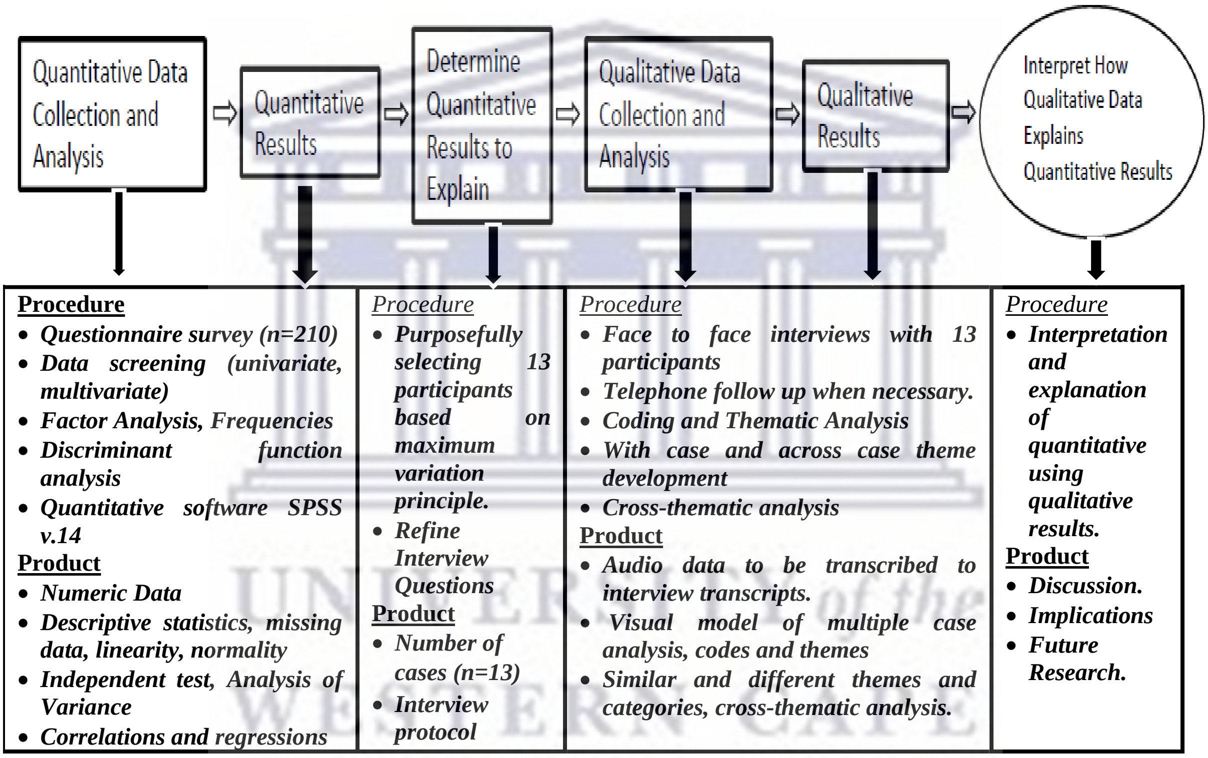


Figure 4-2: Explanatory Sequential Mixed Methods Design. (Source: adapted from Creswell, 2013)

In the first quantitative phase of the study, data were collected using a survey as an instrument to develop an improved preliminary framework. The second qualitative interview phase used semi-structured interviews to validate data collected in the first quantitative phase. The purpose of the exploratory follow-up was to explain or expand on preliminary quantitative results to produce a refined framework. During the first quantitative phase of the study, data were collected and analysed from a sample size of 210 small-scale agriculture stakeholders to develop an improved preliminary framework.

The second qualitative interview phase was carried out to validate the data gathered in the first quantitative phase. In the exploratory follow-up, the improved digital value chain framework was explored with 13 telecommunication and small-scale agriculture sector stakeholders at district, provincial and national government levels, as well as international partners.

The purpose of the exploratory follow-up was to help explain or build on preliminary quantitative results, resulting in a refined and validated framework. Thus, next, the research strategy used to collect relevant data for this research design is discussed in more depth.

4.5 Research Strategy

The research strategy describes how the research was conducted. The strategy can include several different approaches as per the research onion, Figure 4-1, such as experiment, survey, archival research, case study, ethnography, action research, grounded theory or narrative enquiry. These are not discrete entities and may be used in combination in the same research project (Saunders et al., 2019; 2007).

4.5.1 Experiment

The strategy of developing a research process that compares the results of an experiment to the expected results is referred to as experimental research. It can be applied to any field of study and usually involves the consideration of a small number of variables. The relationship between the factors is examined and compared to the expected research outcomes (Saunders et al., 2007).

4.5.2 Survey

A survey is a research method that uses standardised questionnaires or interviews to collect data from a specific group of people. Surveys are useful because they can represent the views of people who do not participate or are underrepresented in other data collection methods. Surveys can collect a wide range of data and provide a statistically representative snapshot of public opinion. They can be administered in a variety of ways and are cost-effective and simpler to implement in relation to other methods of data collection (Saunders et al., 2007).

Surveys tend to be used in quantitative research projects and involve sampling a representative proportion of the population. Surveys generate quantitative data that can be empirically analysed. Surveys are most commonly used to investigate causal variables between different types of data (Bryman & Bell, 2011). Questionnaires collect descriptive and explanatory data by asking people to answer the same set of questions about their opinions, behaviours and characteristics. Data are coded and analysed by a computer. The questionnaire chosen is influenced by the research questions, objectives and resources available. Internet- or intranet-mediated, postal, delivery and collection, telephone and interview schedule are the five main types (Saunders et al., 2007).

Since coding is difficult when dealing with open questions, closed questions are more commonly used in survey research than open ones. Both structured interviews and self-completion questionnaires have advantages and disadvantages. The response rate to postal questionnaires is low. The presentation of closed questions, as well as the overall layout, are important considerations for the self-completion questionnaire (Bryman, 2015).

For this research, the survey implementation consisted of five major stages: (1) Initial design stage, in which a first version of the questionnaire was created; (2) Pilot stage, in which the instrument was tested among a small number of respondents in the area of implementation; (3) Adjustment stage, in which the survey questionnaire was revised and adjusted based on feedback from test participants and surveyors; (4) Roll-out stage, in which the revised questionnaire was implemented in the field; and (5) Data systematisation and analysis where survey data were systematised and analysed using Statistical Package for Social Sciences (SPSS) software.

4.5.3 Archival Research

An archival research strategy is one in which research is carried out using existing materials, which may include a systematic literature review, and patterns of previous research are examined and summarised (Flick, 2011). A critical review of the literature is required to aid in the development of a thorough understanding of, and insight into, previous research that is relevant to the research question(s) and objectives (Saunders et al., 2007).

A literature review assists the researcher to build on the existing body of knowledge and to avoid duplication to address the concepts and issues surrounding the topic. It also ensures that an appropriate theoretical framework is chosen to establish the relationship between these concepts and issues (Mouton, 1998). When planning a literature search, clear research questions and objectives, as well as search parameters, must be defined. The literature review contextualises research by critically discussing previous work, referencing key points and highlighting new insights. It divides literature sources into primary, secondary and tertiary categories and their use depends on research questions and objectives (Saunders et al., 2007).

4.5.4 A Case Study

Case study research is the assessment of a single unit to establish its key features and draw generalisations (Bryman, 2015). Analysis of data is done by identifying patterns and themes from which conclusions are drawn. In a case study, data analysis typically entails the steps of organising the data, categorising the data, interpreting the data, identifying patterns within the data, synthesising and generalising before finally drawing a conclusion (Mouton, 1998).

Case studies are written histories of a specific person, group, organisation or event. The frequency with which the same term (or a synonym) appears in the narrative description identifies themes (Zikmund et al., 2013). Although the case study is often thought to be a single type of research design, it has several forms. It is also critical to be aware of the key issues concerning the nature of case study evidence, such as external validity and generalisability (Bryman, 2015). Case studies are vital tools in scientific enquiry given that they give much information on the context within which they are set (Mouton, 1998). It can provide insight into the specific nature of any example and establish the significance of culture and context in case differences (Silverman, 2013).

To bridge many methodologies and sources of evidence into a single study, an explanatory sequential mixed methods case study research can be employed. This encompasses different paradigms (Jokonya, 2016b). A preliminary conceptual framework with two separate integrated phases is validated in this study using a case study sequential explanatory mixed methods research methodology.

This case study that focuses on small-scale farmers in the Western Cape's West Coast and Overberg districts aims to investigate "digital inclusion". It seeks to explore innovative methods for using digital technology in AVCs to increase the resilience of small-scale farmers, as well as to evaluate and enhance the effectiveness of D4D interventions. Surveys and interviews were both used to gather data. Data were gathered through surveys about the occurrence or incidence in various contexts. In-depth investigations conducted during interviews have the potential to shed light on understandings of certain types of data that may be missed by more comprehensive surveys.

4.5.5 Ethnography

Ethnography is a method of studying cultures that involves becoming highly active within that culture. The researcher immerses himself or herself in the culture being studied and collects data from his or her observations (Saunders et al., 2007). Ethnography involves the close observation of people, examining their cultural interaction and what is meaningful to them. The observer conducts research from the perspective of the people being observed, attempting to comprehend differences in meaning, importance, or behaviour from their point of view (Bryman, 2015; Zikmund et al., 2013).

Ethnography refers to both a research method and the written product of that research. The ethnographer being a participant observer uses non-observational methods and sources such as interviewing and documents. The ethnographer's memory can be jogged by taking field notes, which also provide a lot of the information needed for further analysis. Photographs and videos have caught the attention of ethnographers in recent years, not only as data collection tools but also as objects of interest (Bryman, 2015).

4.5.6 Action Research

Action research is defined as a hands-on approach to a specific research problem conducted within a community of practice (Bryman, 2015). It involves examining practice to establish that it corresponds to the best approach. It usually includes reflective practice, which is a systematic process for evaluating practitioners' professional practice and experience (Wiles et al., 2011).

Participatory Action Research (PAR) is a research method that emphasises participation and action. It tries to understand the world by attempting to alter it cooperatively after reflection. PAR places a strong emphasis on community-based research and experimentation that is informed by social history and experience (Saunders et al., 2007).

4.5.7 Grounded Theory (GT)

A qualitative methodology known as Grounded Theory (GT) is commonly used in the social sciences. GT relies on an inductive strategy in which patterns are discovered in the data before the study even begins (Bryman, 2015). For example, interview data can be transcribed, coded and then grouped based on the common characteristics shared by respondents. This means that the research results are derived primarily from the completed research, rather than the data being examined to determine whether it fits within pre-existing frameworks (Flick, 2011).

Grounded theory is a type of inductive investigation in which the researcher asks questions about information provided by respondents or gleaned from historical records. The researcher poses the questions to himself or herself and repeatedly questions the responses in order to elicit more detailed explanations (Zikmund et al., 2013).

4.5.8 Narrative Enquiry

Narrative analysis is a method that emphasises the stories that people tell the qualitative researcher during interviews and other interactions. A narrative review is a more traditional approach with the benefit of flexibility, making it more suitable for inductive research and qualitative research designs. It is made up of narratives, interpretations and perceptions that claim to have a value-bound, reflexive axiology (Bryman, 2015).

Different methodologies for social research, including important epistemological and ontological considerations, comprise quantitative and qualitative methods. Theory can be depicted as something that precedes research (as in quantitative research) or as something that emerges out of it (as in qualitative research). Practical considerations in research method decisions are also important (Bryman, 2015). One of these practical considerations is determining the time horizon, which will be discussed next.

4.6 Identifying the Time Horizon

The Time Horizon is the timeframe in which the project is expected to be completed (Saunders et al., 2007). The research onion specifies two types of time horizons namely, cross sectional and longitudinal (Bryman, 2015).

The cross-sectional time horizon is one already established, whereby the data must be collected. This is known as snapshot time collection, and the data is collected at a specific point in time (Flick, 2011). When the investigation is concerned with the study of a specific phenomenon at a specific time, this is used.

A longitudinal time horizon for data collection refers to the collection of data repeatedly over an extended period and is used when examining change over time is an important factor for the research (Goddard & Melville, 2004). This has the advantage of being useful for studying change and development. Furthermore, it allows for some control over the variables being studied (Saunders et al., 2007).

4.7 Quantitative Data Collection

Quantitative research is a structured, impartial, exacting and organised method for gathering data. It looks at how variables relate to one another and evaluates how well certain actions affect these variables (Gliner et al., 2009). The quantitative methodology is based on a realist or positivist approach in which the researcher is detached from the situation under investigation. It manipulates observations to provide a numerical representation to describe and explain the phenomena that those observations reflect (Tuli, 2005). Quantitative research address research objectives through empirical assessments that include numerical measurement and analysis. Quantitative methods use measurement to test hypotheses or specific research questions. The researcher as an uninvolved observer provides a structured response with categories. The results are objective, and large samples are used to produce results that are generalisable to other situations (Zikmund et al., 2013)

Quantitative research can either be descriptive, correlational, quasi-experimental or experimental research (Williams, 2007).

- Descriptive research outlines the distinctive characteristics of the subjects being studied.
- The association between two or more variables is examined in correlational research. It establishes the nature and strength of the relationship plus explains what is observed.
- Cause-and-effect relationships are examined in quasi-experimental research. The researcher has less control than pure experimental designs. Samples are not chosen at random, and the researcher has no control over any of the study's factors.
- The controlled manipulation of at least one independent variable is one of the key features of experimental research. The sample is randomly assigned to the experimental and control groups. Exploring cause-and-effect correlations through rigorously controlled, impartial, systematic studies is the goal of experimental research. Measurements of both independent and dependent variables are required.

(Williams, 2007).

A research design serves as a guide for carrying out the investigation. It maximises control over variables that might affect how the study turns out. It specifies the population to be studied, sampling procedures, measurement techniques, data-gathering strategies and analysis plans. A research study's objectives include describing variables, examining relationships, identifying differences, testing an occurrence and providing a foundation of evidence for practice or a mixture of the things that were mentioned (Ghasemi & Zahediasl, 2012).

Rigour, control, extraneous variables, sampling, applied research and basic research are crucial concepts in the quantitative research process. Real-world problems are addressed through applied research, which also examines the potential effects of the intervention and applies research findings to actual problems. To pursue quality in research and commitment to detail, rigour is crucial. It is crucial to have precise measurement instruments, a representative sample, a well-controlled study design and logical reasoning (Gliner et al., 2009).

Table 4-2: Measures of Control in Quantitative Research

Quantitative Research	Researcher Control	Research Setting
Descriptive	Uncontrolled	Natural or partially controlled
Correlational	Uncontrolled or partially controlled	Natural or partially controlled
Quasi-experimental	Partially controlled	Partially controlled
Experimental	Highly controlled	Laboratory

(Source: Williams, 2007)

In a study design, the role of control is to boost the likelihood that the findings are accurate. When doing various types of quantitative research, the level of control by the researcher and the methods for controlling the research environment are shown in Table 4-2.

The steps in quantitative research are data gathering, problem description with a plan that defines goals and identifies solutions. Implementation, evaluation and revision are all included in the problem-solving process. The process of choosing subjects who are typical of the population is known as sampling and sampling methods. Each participant in a random sample has an equal probability of getting chosen and the most control. Whoever is accessible is used for convenience sampling. A sample is a portion of the population that is chosen for study, while a population is all elements that satisfy specified criteria for inclusion in the study (Ghasemi & Zahediasl, 2012). The quantitative approach was used in this study to establish, confirm and refine relationships. Survey research, using questionnaires was used to collect data to establish existing relationships between variables and explain the possible reasons or causes for those relationships. This avoided generalisations, improved results and understanding of the subject at hand, and aided in the development of new concepts about the phenomenon.

It is critical to establish the reliability and validity of measures to assess the quality of the research. Many qualitative researchers have criticised quantitative research, claiming that a natural science model is inappropriate for studying the social world (Bryman, 2015). Several accepted statistical standards for the validity of the approach are held by quantitative data, such as the number of respondents required to establish a statistically significant result. Despite being informed by a positivist philosophy, this research approach can be used to investigate a wide range of social phenomena. It is most effective when there are a large number of respondents available; data can be effectively measured using quantitative techniques and statistical methods of analysis (Zikmund et al., 2013).

Data collection in quantitative research is the precise, systematic gathering of information for the study. Consent must be obtained from the sample. Researchers use observation, interviews, questionnaires or scales to gather information (Gliner et al., 2009). Surveys are the most common method of gathering primary quantitative data and were also used for this study. The questionnaire design and survey process continued throughout the initial part of the study to prevent the common mistake of concluding it too soon. It was critical to exhaust all secondary research sources before embarking on the primary research activities. It was ensured that there was a clear understanding of the research issues and objectives, which is often obtained through exploratory qualitative research.

An error exists in all surveys and is classified as either random sampling error or systematic error:

- *Random sampling error* exists due to chance variation in the sample elements and can only be addressed by using a large sample size.
- *Systematic error* is caused by a flaw in the research design or execution. The researcher must minimise systematic error (Zikmund et al., 2013).

4.7.1 Guideline of Quantitative Sample Size

Probability sampling is a technique for minimising bias in sample selection. Randomly selected samples are important because they allow generalisations to the population and have certain known characteristics. As the sample size increases, sampling error decreases. Quota samples can be a good alternative to random samples, but they have some drawbacks. Convenience samples can provide interesting data, but they have limitations in terms of generalisability. In survey research, sampling and sampling-related error are just two sources of error (Saunders et al., 2007). This method differs from quantitative research's random sampling procedures, which are based on statistical probability theory (Bryman, 2015).

Table 4-3: Sample size rules of thumb

Relationship	Reasonable Sample Size
Measuring group differences (e.g., t-test, ANOVA)	Cell size of 30 for 80% power, if decreased, not lower than 7%
Relationships (e.g., Correlations, regression)	50 and above
Chi-square	At least 20 overall, no cell smaller than 5
Factor Analysis	300 is good

(Source: Adapted from Van Voorhis and Morgan, 2007)

Van Voorhis and Morgan (2007) argue that, unlike qualitative research, which lacks an agreed-upon sample size, quantitative research provides guidelines on sample sizes required for various statistical procedures. This means that every quantitative statistical procedure has sample size guidelines (see Table 4-3). Most researchers propose that statistics for detecting differences between or among groups (t-tests, ANOVA) require 30 participants per cell to achieve the minimum suggested power for an ordinary study. For statistics used to examine relationships (correlation and regression), a general rule of thumb is 50 or more participants (Van Voorhis & Morgan, 2007).

According to Table 4-3, Chi-square, which examines the independence of category variables, necessitates at least 20 cells in total, with no cell smaller than 5. Factor analysis necessitates a sample size of at least 200-250, with 50 participants per factor. As a result, a sample size of 210 cases was determined to be adequate for validating the preliminary digital AVC implementation framework.

Data were sourced from stakeholders identified at the micro, meso and macro levels. The micro level includes individual small-scale farmers, farmer associations and community-based organisations. The meso level included representatives from NGOs or private sector companies working at district or provincial level, municipalities, government representatives and cooperatives. The macro level includes representatives from government ministries and national public sector organisations, international donors and other relevant organisations working at national level.

The survey targets small-scale farmers' stakeholders which will provide enough variations and information needed for this study. Respondents will further be stratified by the type of activities involved, such as small-scale farmers, extension workers, input dealers and market dealers. A simple random sampling technique will then be employed to select the required number of respondents who will as much as possible form a comprehensive case study. All sample units will be personally contacted and interviewed.

The sampling frame was a list of all small-scale farmers in the West Coast and Overberg District Municipalities. The sampling unit was the small-scale farmer stakeholders. The sample size depended on the population of small-scale farmers' stakeholder size of the two District Municipalities. For the questionnaire survey, an estimated sample of between 5% and 15% of the population was considered statistically satisfactory.

For the questionnaire survey, small-scale farmers were chosen using a random sampling technique. Random sampling, which is a key feature of quantitative research, controls for selection bias and allows generalisation from the sample to a larger population (Bryman, 2015). The nature of small-scale farmer digital technology adoption and use in their AVCs was investigated using a small-scale farmer questionnaire. In addition, their interactions with institutions at all levels were examined. The interaction of small-scale farmers, institutions and politics influence their decision to adopt digital technology.

4.7.2 Reliability Test

The three major evaluation criteria for measurements are reliability, validity and sensitivity. The internal consistency of a measure is indicated by its reliability. The accuracy of a measure or the extent to which a score accurately represents a concept is referred to as validity. The ability of a measurement instrument to accurately measure variability in stimuli or responses is referred to as sensitivity (Zikmund et al., 2013).

When collecting data, the central consideration of validity is reliability. The same set of data analysed under different circumstances and by different groups using the same methods must yield the same results. Thus, the researchers, the participants, the measuring instrument, and the research context all have an impact on data reliability (Mouton, 1998). The consequences of random error, which results in normal variation in scores, are considered by the reliability theory. A combination of inaccuracy and genuine score is said to be present in the measured score. The standard error of measurement is determined to identify the range surrounding the observed score that the true score is likely to fall into. The reliability of the metric increases as this bracket gets smaller and decreases as it gets wider. Even if a measure is reliable, bias (systematic error) may prevent it from being valid (Koonin, 2014).

In general, how the data were collected and processed established the reliability and validity of the study. Issues to consider when conducting a survey are the dependability of delivery, literacy rates and trust that researchers can and will provide confidentiality. In some cases, handing out surveys or conducting door-to-door interviews may be required (Zikmund et al., 2013). The inclusion of multiple sources of data collection can influence data reliability, and this use of multiple methods of data collection is known as triangulation (Mouton, 1998).

The degree to which each item correlates to the other items is how inter-item dependability is measured. To check the internal consistency, this calculation is made. Since they collectively measure the same thing, things should theoretically correlate to some extent. This should not be so high though that the things are not suitably one of a kind. To identify which items are improperly connected to the other items or the test/scale as a whole, item analysis may be used. To improve the instrument's dependability, these may need to be altered, rewritten or replaced with another component. (Koonin, 2014). The internal consistency of a measure is indicated by its reliability (Zikmund et al., 2013).

Table 4-4: Cronbach Alpha Reliability Test

Construct	N of Item	Items left out	Mean	SD	Cronbach	Reliability
Robustness	3	none	4.51	1.37	0.66	Good
Self-Organisation	2	none	3.02	1.15	0.65	Good
Learning	2	LEATRA	3.34	1.08	0.61	Good
Redundancy	3	none	4.53	1.6	0.63	Good
Rapidity	2	RAPSUPP	2.33	0.735	0.573	Unacceptable
Scale	3	none	4.72	1.73	0.81	Good
Diversity and Flexibility	4	none	4.84	1.43	0.77	Good
Equity	3	none	5.2	1.67	0.64	Good

Note: (n=210)

Averages were employed to test the construct dependability in Cronbach's alpha. Reliability is the constancy of an instrument when used to measure the same subject under the same circumstances (Peterson, 1994). Data reliability is determined by how reliable the statistic of digital technology adoption in AVCs of small-scale farmers is and how thorough the methods used were. This study incorporates multiple data sources to increase the reliability of the research. The reliability and acceptability of the questionnaire constructs (themes) were assessed using Cronbach's alpha values. Unreliable variables were eliminated before calculating construct variable scores using the Cronbach alpha test to determine the reliability of the variables (see Table 4-4).

The interpretation of Cronbach's alpha values is good for reliability greater than 0.8, acceptable for reliability between 0.6 and 0.8, and poor for reliability less than 0.6. The acceptable reliability threshold, according to some authors, is 0.7 (Peterson, 1994). To increase the index's reliability, certain elements were dropped from the index after they had poor correlations. Eliminated from the set are any items with an alpha Cronbach's alpha of less than 2%. The reliability outcomes from the survey constructs are displayed in Table 4-4.

The table shows from left to right construct, items included, items left out, mean, SD, Cronbach Alpha value and reliability interpretation. Almost all the questionnaire constructs were above 0.6, which is an indication of good reliability for all the constructs.

Respondent error, intra-individual factors and administration error are factors that influence reliability. The responder error comprises non-response bias, answer sets, intentional falsification and unintentional misrepresentation. The intra-individual factors include individual score variability, such as range limitations and sample ability levels. Variations in instructions, assessment parameters, instructions interpretation and scoring or ratings constitute administration errors (Babbie, 2016).

4.7.3 Validity Test

The most important rationale placed on the scientific nature of research to ensure the validity and credibility of findings is methodological analysis. It creates and communicates strategies to increase the validity and credibility of research findings (Mouton, 1998). The accuracy of a measure or the extent to which a score accurately represents a concept is referred to as validity. To establish validity, reliability is required but not sufficient. A measure can be both reliable and invalid. A valid measure, on the other hand, is reliable. The issue here is the ability to establish dependability and validity (Zikmund et al., 2013).

Table 4-5: Different forms of validity in Quantitative research

Face validity:	**A** scale's content logically appears to reflect what was intended to be measured. This may be assessed in the piloting process.
Content validity:	The degree that a measure covers the breadth of the domain of interest. Experts on the topic may be consulted in order to advise in this regard.
Criterion validity:	The ability of a measure to correlate with other standard measures of similar constructs or established criteria. Predictive validity can predict future behaviour and concurrent validity correlates to the performance of some task in alignment with a criterion.

Construct validity:	Exists when a measure reliably measures and truthfully represents a unique concept; consists of several components including factorial, correlation, incremental, convergent, discriminant, differential, sensitivity and specificity.
Convergent validity:	Concepts that should be related to one another are in fact related; highly reliable scales contain convergent validity.
Discriminant validity:	Represents how unique or distinct is a measure; a scale should not correlate too highly with a measure of a different construct.

(Source: Zikmund et al., 2013; Koonin, 2014)

The assessment of reliability is relatively simple, whereas validity is much more difficult. Indeed, validity can never be unequivocally established; validity must be inferred. So, if the method is untrustworthy, there is no reason to attempt the more difficult task of determining validity. In general, the data source's details about how the data were collected and processed establish reliability and validity (Zikmund et al., 2013). A test's validity is defined by what it assesses and how accurately it is measured. To establish objectivity, a test must consistently measure the construct it is intended to measure across all groups. Validity is impacted by measurement consistency (reliability). "Unitary validity" refers to the compiled data from the validity-testing procedure. As a multi-dimensional construct, validity can be assessed at different levels, including face validity, content validity, construct validity and criterion-related validity (Koonin, 2014). Table 4-5 shows the various types of validity when conducting quantitative research.

Validity is influenced by characteristics like sample homogeneity, subgroup effects and reliability. The validity and reliability of a measure are adversely connected. For a measure to be regarded as valid, it must consistently measure the desired outcome. If the influence of the various subgroups varies, a meaningful metric is constant across them. Because of the sample's homogeneity, it is possible to find ratings that are similar throughout it. This can result in bias if it is applied to a different group. When piloting and evaluating the measure, the sample should be used, and any limitations on its application to additional samples should be made clear (Koonin, 2014).

The trade-off between internal and external validity must be considered. Controlling extraneous variables to the greatest extent possible improves internal validity. Internal validity is high because it increases the certainty that the experimental variable is the true cause of any variance in the dependent variable. Field experiments, like the self-efficacy study, maximise external validity, which means that the results are more likely to generalise to the real world. External validity is sacrificed at the expense of internal validity (Zikmund et al., 2013).

The trade-off between reliability and validity has consequences because a measurement should ideally be both reliable and valid. In practice, there is frequently a compromise between the two. The validity of a measure is constrained by its reliability (Foxcroft & Roodt, 2019). As a result, a highly reliable measure will only have limited validity as validity improves and reliability declines (Koonin, 2014). Thus, a construct must have depth and breadth of meaning in order to be measured in its real form and for the measurement to be considered valid. Only with limited reliability will it be possible to quantify a construct's depth and breadth consistently.

4.7.4 Generalisability

Whether or not the sample is thought to be sufficiently representative of the community from which it was obtained is what determines generalisability. If so, the study's findings can be extrapolated and applied to the general population. In other words, "external validity" is what this is. This is the main objective of quantitative research and the main justification for sampling. For inferential statistical analysis, a normally distributed sample is necessary since it is statistically likely to be representative of the population (Babbie, 2016).

The factors affecting generalisability include sample size, sampling method and reliability plus validity.

- *Sample size:* The likelihood of generating a sample that is statistically normally distributed and representative of the population can be improved by using a big sample. Nevertheless, a small sample size does not imply that the sample is not representative in all cases.

- *Sampling method:* Using random sampling techniques can improve the likelihood of getting a representative, evenly dispersed sample. To achieve a representative sample, one can use a purposive strategy, such as quota sampling, which involves choosing people who are proportionately representative of the population (Bless et al., 2013).

- Data will probably not be accurate if the instrument is not valid or reliable, making it difficult to confidently generalise the findings. It is important to take note of any limitations on validity and reliability since they may prevent the results from being extrapolated outside of the sample. Findings can be more confidently generalised to the population if the instrument is reliable and valid. To correctly assess whether the sample is representative of the population, it is critical to have a solid grasp of the population. The results can then be generalised to the population with greater confidence (Koonin, 2014).

A biased instrument complicates the interpretation of the results since it obscures the real impact. An alternative name for bias is systematic or non-random error. Significant differences that are measured may be the result of group differences rather than actual differences in the construct if an instrument is biased. The tool may not measure the same construct for all persons since different groups might understand or respond to questions differently. Fairness refers to an instrument's lack of prejudice, which enables it to be utilised consistently (reliability) and correctly (validity) for everyone. A biased instrument cannot be used to evaluate everyone equally (Bless et al., 2013).

In conclusion, a measure cannot be considered to consistently or properly measure what it is intended to measure if it is not reliable or valid. This implies that it might be unjust and biased. The results of a biased measure are not accurate or trustworthy, hence using it is immoral. The results must be sufficiently valid and reliable before they can be generalised to the population as a whole. By minimising and removing bias as much as feasible, this study attempted to implement best practices in research. Validity and reliability were assessed as part of the methodology of the study. This made sure that the psychometric characteristics accurately reflected the calibre of the tool and data it generated. This impacted the statistical testing. As an existing tool was used, it was examined to make sure it was of a good standard and wasn notbiased or unfair. Resources and the thesis's scope dictated how far the study of psychometric qualities would go. Large-scale primary research was conducted as part of the study to perform complex explanatory statistical analyses. As a result, a detailed evaluation of psychometric qualities was carried out as part of the quality control procedure.

4.7.5 Quantitative Data Analysis

Data analysis is a challenging process that requires switching back and forth between descriptive and interpretive steps, inductive and deductive reasoning, and tangible and abstract notions. Making sense of data is hence the process of data analysis. Data must be described in detail during the analysis phase in order to show differences, correlations and other patterns that exist in the data, as well as to respond to research questions or test hypotheses (Mertler & Charles, 2005).

Quantitative data analysis is the study of tabulated material or information to determine inherent facts or meanings and create knowledge. It entails breaking down existing complex factors into simpler information components to make raw data meaningful, turning it and arranging the parts in new ways for interpretation to provide us with new information (Singh, 2006). Effective data analysis requires maintaining the primary goal, managing the data, conducting qualitative analysis, presenting the findings and drawing pertinent and comprehensible conclusions (Gliner et al., 2009).

Data analysis entails organising data, categorising data, interpreting data, identifying patterns within data, synthesising and generalising, and finally drawing a conclusion (Mouton & Marais, 1998). Quantitative data are often disorganiz#sed numerical data with ambiguous meanings. Statistical analysis helps organise and concentrate this data, simplifying it into manageable knowledge and revealing patterns and linkages. Statistics summarises data, identifies norms, determines individuals' status, illustrates connections, displays differences, recognises sample selection inaccuracy, assesses significance, and assists researchers in drawing inferences about the population (Ghasemi & Zahediasl, 2012).

Data analysis is the use of reasoning to understand the information gathered (Zikmund et al., 2013). Before designing research instruments, researchers must consider data analysis. Data analysis techniques apply to only some types of variables, so it is critical to understand the distinction between nominal, ordinal, interval or ratio and dichotomous variables. It is critical not to put these considerations off until after the data has been collected, and not to confuse statistical significance with substantive significance (Bryman, 2015). In this study, the analysis and interpretation of data was started early with a plan where data were coded, entered and cleaned. Before designing the research instruments, SPSS was identified. Data were then analysed, interpreted and reflected on. The objective was to see the meaning of the data, draw conclusions, make suggestions and analyse the limitations.

Data for quantitative analysis can be gathered and coded at various levels of numerical measurement. The data type will limit the data presentation, summary and analysis techniques that can be used (Saunders et al., 2007).

Table 4-6: A measurement scale for quantitative variables

Measurement scale	Characteristics	Statistical possibilities
Nominal scale	Used to categorise participants. Nominal data contain multiple values that cannot be quantified.	Frequency distribution (mode), Proportions (percentage values), Chi-square

Ordinal Scale	Measurement variable based on nominal scales and assigns numbers to represent a rank or ordering.	Median, Percentile rank, Spearman rank order, Correlation, Mann-Whitney test
Interval Scale	The difference between two data values that gives credible meaning is an interval scale	Mean, Standard deviation, Pearson Product-moment, Correlation, Inferential procedures (e.g., t-test, ANOVA)
Ratio Scale	Data measured by equal units. Absolute zero point established.	Geometric mean, Percentage variance, Inferential procedures

(Source: Bryman, 2015; Gliner et al., 2009)

Measurement is the process of putting numbers on things and using rules to create a measurement tool or instrument. At the nominal, ordinal, interval or ratio level of measurement, data were collected. The level of measurement helps in selecting the appropriate statistical method afterwards. It is necessary to assess the measurement tool's validity and dependability. A measurement scale can be classified into one of the following four groups: nominal, ordinal, interval and ratio, as depicted in Table 4-6 (Gliner et al., 2009).

Existing coding schemes were used where possible to enable comparisons. To reduce coding after collection, pre-set codes on the data collection form were included for primary data. After collecting data for the first 50 to 60 cases, a codebook was created for variables with unknown responses. All data values, including missing data, were coded, and the data matrix was checked for errors.

Quantitative measurement levels can be categorical or continuous. Categorical measurement is nominal, while continuous measurement is appropriate when there are equal differences in attributes and numerical differences. Continuous measurement is a ratio when there is a true absolute zero, indicating the absence of the measured feature (Williams, 2007).

Data are entered into a computer for analysis as a data matrix, with each column representing a variable and each row representing a case. To facilitate error checking, the first variable should be a unique identifier. With a few exceptions, all data should be recorded using numerical codes to facilitate analyses (Saunders et al., 2007).

The analysis utilised tables and diagrams to analyse data, focusing on specific values, bar charts, histograms, line graphs, proportions, box plots and scatter graphs. These methods were influenced by research questions and objectives.

Further analyses involved describing data and exploring relationships using statistics influenced by the research questions and objectives, as well as the level of measurement at which data were collected. The analysis may include the use of statistics such as:

- Mean, median and mode to describe the central tendency.
- The inter-quartile range and standard deviation describe the dispersion.
- Chi-square, Cramer's V, and phi to determine whether the two variables are significantly related.
- The Kolmogorov-Smirnov test to determine whether the values differ significantly from a given population.
- T-tests and ANOVA to determine whether groups differ significantly; correlation and regression to determine the strength of relationships between variables.
- Regression analysis to forecast values.

The independent variable (IV) is the type of quantitative variable that the researchers control. Levels of the independent variable are the various ways that the independent variable could change. The dependent variable (DV) is a measurement based on the change from the IV. The IV change affects how the DV reacts. The DV should have changed in some way if the IV is modified (Foxcroft & Roodt, 2019).

Longitudinal data may necessitate selecting different statistical techniques such as index numbers to establish a trend or to compare trends between two or more variables measured in different units or at different magnitudes and moving averages and regression analysis to determine the trend and forecast (Saunders et al., 2007). Any other variables that affect the results besides the independent variable are known as confounding variables. This relates to the independent variable change not caused by the independent variable. An experiment can only have one IV and other variables include a moderator variable that influences the strength of a relationship between two other variables and a mediator variable that explains the relationship between the two other variables (Foxcroft & Roodt, 2019).

Descriptive statistics were employed in this study to summarise and provide a description of the events that took place. The three basic types of descriptive statistics—measures of central tendency, measurements of dispersion and measures of relationship—are often used.

- The three components of central tendency are mean (arithmetic average of a set of values), median (the middle value in a set of values) and mode (the value that appears most frequently in a set of values). This central tendency analysis of the individual variables, which provides the distribution's average, was used to characterise the group's overall performance, attitude or opinion among the study participants.

- Range (Highest minus Lowest) and standard deviation (the average distance to scores from the mean) are the two main measurements of dispersion. The dispersion measurements are used to show what is unique about a group of scores and how much variability or spread there is within a group of scores.
- The third category of descriptive statistics measures is relationship measures. Correlation coefficients, the name given to these diverse measures of the nature and strength of the relationship between two variables, come in a wide variety of forms. It is computed when data from research using a correlation design are analysed.

(Gliner et al., 2009).

A few data analysis methods that were used for this study included descriptive statistics, Chi-square tests and correlation analysis, together with multinomial regression and logistic regression. The results of the study were used to refine the framework for implementing digital technology adoption in AVCs of small-scale farmers. Data were presented in the form of a narrative analysis and graphical representations, as well as tables and flow diagrams.

This phase incorporates various mechanisms for validating fieldwork findings to improve the validity and reliability of the data collected. Data from surveys were coded and fed into SPSS software for analysis, and Microsoft Excel spreadsheets were used to provide means, and frequency and to draw various charts as needed.

After comparing the literature and the data collected using the tools described above, credible recommendations are made. Data obtained through key informant interviews were analysed using content analysis. Descriptive statistical analysis was used to summarise information and investigate the data for response distribution. The study's goal in combining different research methods is to strengthen the credibility and validity of the results through triangulation. This leads us into discussing the qualitative data collection phase next.

4.8 Qualitative Data Collection Phase

When doing qualitative research, non-numerical data (such as text, video or audio) are gathered and analysed to better comprehend ideas, beliefs or experiences. It can be utilised to uncover intricate details about a situation or to spark fresh study concepts (Creswell, 2013). The qualitative methodology combines data into belief systems with case-specific manifestations and employs techniques such as reviews, action research, case studies, descriptive/interpretive, futures research and role/game playing to produce results (Tuli, 2005). Qualitative work can be positivist when it documents processes that consistently lead to one outcome, and it can also be interpretivist when it seeks general concepts that people believe at a given time (Chin Lin, 1998).

The qualitative approach is based on the constructivist paradigm and requires the researcher to avoid imposing their interpretation of the meaning of social phenomena on the respondent. The goal is to learn how the respondent interprets their reality. A methodology that is framed by the respondent rather than the researcher should be developed (Zikmund et al., 2013). The collection of qualitative data frequently results in the accumulation of a large volume of information. Qualitative data analysis is not governed by codified rules in the same way that quantitative data analysis is (Bryman, 2015). Qualitative research investigates phenomena, situations, understanding and gathering participant stories to answer study questions in their native environment (Yilmaz, 2013).

The complement of qualitative research is quantitative research, which gathers and examines numerical data for statistical analysis. The use of qualitative research is common in a variety of humanities and social science disciplines, including that of anthropology, sociology, educa tion, the health sciences, history, public administration and other related topics (Saldana, 2013). Qualitative data can be gathered through interviews or texts in which the answer to a question can be left open. Furthermore, the researcher can develop questions throughout the process to ensure that the respondent expands on the information provided. Rather than seeking a causal relationship between established variables, qualitative research is typically used to investigate the meaning of social phenomena (Zikmund et al., 2013).

In comparison to quantitative research, qualitative research is more likely to raise ethical concerns, though all research methods raise ethical concerns (Saunders et al., 2007). Qualitative research addresses objectives by employing techniques that enable the researcher to provide detailed interpretations of a phenomenon without relying on numerical measurement. The emphasis is on uncovering true inner meanings and gaining new insights. This is a researcher-dependent study in which the researcher must extract meaning from unstructured responses such as text from a recorded interview (Zikmund et al., 2013).

Table 4-7: Common Qualitative Research Tools

Tool	Description	Type of Approach (Category)	Key Advantages	Key Disadvantages
Focus Group Interviews	Moderator leads small group discussions	Ethnography, case studies	Can be completed quickly. Obtain a variety of viewpoints. Flexibility	Results are affected by the moderator. The findings do not apply to a larger population. For sensitive topics, it is difficult to use. Expensive
Depth Interviews	An in-depth interview with the respondent	Ethnography, grounded theory, case studies	A lot of information from each person. It is useful understanding unusual behaviours	The outcome is determined by the researcher's interpretation. The findings are not intended to be generalisable. Extremely costly
Conversations	Researchers record unstructured conversationss	Phenomenology, grounded theory	Get insights from enthusiasts. Can discuss sensitive topics. Less costly	It is simple to veer off course. Interpretations are extremely researcher dependent
Semi-Structured Interviews	Open-ended, writing respondents provide essay-style responses	Grounded theory, ethnography	Can deal with more specific issues. The results are simple to interpret. Advantages in terms of cost	Lack of the adaptability required to generate truly creative or novel explanations
Word Sentence Completion	Consumers responses to stimuli are recorded.	Grounded theory, case studies	Economical and quick to complete	Lack of the adaptability required to generate truly creative or novel explanations
Observation	Notes taken while observing events	Ethnography, grounded theory, case studies	It is possible to be unobtrusive Can produce actual behavioural patterns	Participant-observer series can be very expensive
Collages	Respondent creates a collage of images that represent thoughts and feelings	Phenomenology, grounded theory	Flexible enough to allow novel insights	The researcher's interpretation of the collage is crucial
Thematic Apperception/ Cartoon Tests	The researcher paints an ambiguous picture, and the respondent tells the story	Phenomenology, grounded theory	Projective, allows us to get at sensitive issues Flexible	The interpretation of the researcher is extremely important

(Source: Adapted from Zikmund et al., 2013)

In table 4-7, there are some common qualitative research tools. Thus, qualitative research data collection strategies include observation, participant observation, in-depth interviews, document collection plus analysis and focus groups. The characteristics of the data are audio, text and visual (Yilmaz, 2013).

4.8.1 *Choosing an appropriate qualitative research approach*

While capturing participants' experiences, a qualitative research question may be exploratory ontological; however, when comprehending a phenomenon, it may be exploratory epistemological (Saldana, 2013). The following factors need to be considered when choosing an effective research approach:

a) Evaluating the methodological foundations of possible qualitative research approaches

- Phenomenological approach: capturing participants' experiences, looking at how they interpret them and developing themes that reflect those experiences.
- Grounded Theory approach: creating a theory, statement, model or explanation that best fits the evidence gathered and offers insight into a phenomenon, circumstance or process.
- Narrative approach: gathering participant stories and using data analysis to retell the participants' tales in a predetermined fashion to answer the research question.
- Case Study: using many data sources, it sheds light on or offers a thorough understanding of a particular or clearly defined situation or event.
- Ethnography: investigating a phenomenon through observing a person, group or environment in its natural setting as they interact with other people and their environment (Creswell, 2013; Yilmaz, 2013).

b) The following factors are considered when using an elimination method:

- Examining the characteristics of the research question(s).
- Discarding the research approaches that do not support the research question(s).
- Identifying the type of data required to answer the research question(s).
- Compare the anticipated data with the methodology rationale/objective of each prospective research approach (Creswell, 2013; Yilmaz, 2013).

c) Engaging in a process of elimination.

This study employs a phenomenological approach to record the experiences of small-scale farmer stakeholder participants as they integrate digital technology into their

AVCs, examine how they perceive those experiences and create themes that reflect those experiences.

Table 4-8: Process of Elimination (Choosing an appropriate qualitative research approach)

Type of research question		Examples	Potential Research Approach
Qualitative research question (Exploratory)	Exploratory-Ontological research question: (Capturing participants' realities)	• What kind of thing is it? • What intense experiences have you had with ...? • What does it feel to be ...?	• Phenomenological approach • Narrative approach • Ethnography
	Epistemological research question: (Understanding phenomenon)	• How does it work ...? • What does it mean to be ...? • What factors affect ...?	• Case Study • Ethnography • Grounded Theory approach • Phenomenological approach

(Source: Adapted from Saldana, 2013)

Table 4-8 above gives a diagrammatical representation of the process of elimination.

4.8.2 Qualitative Sample Size Selection

The credibility of the study is dependent on the quality of the procedures used to select research participants. Qualitative researchers object to the term "sample" being used in qualitative research, preferring terms like "research participants" or "selected participants" (Bryman, 2015). It is critical to identify and describe the methods used to select the research sample in detail. This gives the reader a sense of the scope of the study and helps them understand why the specific method of sample selection considered is the best.

Table 4-9: Qualitative Sampling Techniques

Sampling Technique	Meaning
Intensity sampling	Appropriate if you plan to explore different components of a case, phenomenon, situation, and/or behaviour with varied intensity
Homogeneous sampling	Focus on participants who have similar experiences, beliefs and/or background
Criterion sampling	Selecting participants who meet specified criteria
Snowball sampling	Recruit participants based on the recommendation of the initial participants sampled
Random purposive sampling	Randomly sampling participants who have been purposively sampled

(Source: Jacobs, 2013)

According to Jacobs (2013), the sampling techniques in Table 4-9, such as intensity sampling, homogeneous sampling, criterion sampling, snowball sampling and random purposive sampling, can be used in qualitative research.

The number of participants in a qualitative study is determined by the research approach selected, suggestions made by qualitative researchers, the similarity of participant backgrounds, participant accessibility, the attainability of saturation and availability of time and resources, as well as the suitability of the potential data to answer the research question(s) (Baker & Edwards, 2012). For this research, the sample is purposefully chosen and this type of sampling in qualitative research is also known as random purposeful sampling (Merriam, 1998). This study used the logic of random purposeful sampling because it is based on selecting cases with a lot of information to gain insight and understanding of the phenomenon under investigation. The number of participants in this qualitative study will be determined during the quantitative phase of this mixed methods sequential research.

4.8.3 Qualitative Interviews

Non-standardised (qualitative) research interviews enable the collection of a rich and detailed set of data. A sufficient level of competence is required to conduct and gain access to the type of data associated with their use (Saunders et al., 2007). Understanding the subjective meanings held by actors is the goal of qualitative research (interpretivist epistemology). Interviews and ethnography are common methods for gathering data in the form of words, texts and stories. It employs an inductive approach in which theory emerges from data, along with a social constructionist ontology (Bryman, 2015).

Interviews can be classified based on the level of structure and standardisation used. Different types of interviews are useful for various research purposes. Non-standardised qualitative research interviews are divided into two categories: in-depth or unstructured interviews and semi-structured interviews. Non-standardised interviews can be used to investigate topics and explain other findings (Saunders et al., 2007). Narrative analysis has evolved into a distinct strategy for analysing qualitative data. Secondary analysis of qualitative data is becoming a more prominent activity than in the past (Bryman, 2015).

More than one type of interview may be used in the research design. In both quantitative and qualitative research, in-depth and semi-structured interviews can be used. There are circumstances in which non-standardised (qualitative) interviews will be used to collect data. Apart from the nature of the research strategy, these are related to the importance of making personal contact, the nature of data collection questions and the time required from participants to provide data (Saunders et al., 2007).

4.8.4 Qualitative Data Analysis

The process of qualitative analysis generally entails the creation of data categories, the assignment of units of original data to appropriate categories, the recognition of relationships within and between data categories and the development and testing of hypotheses or propositions to produce well-grounded conclusions (Saunders et al., 2007). There are various approaches to qualitative data analysis, the most prominent of which is probably grounded theory (Bryman, 2015). There are six (6) common qualitative analysis techniques, which include Content analysis, Narrative analysis, Discourse analysis, Thematic analysis (TA), Grounded analysis and Interpretive phenomenological approach (Creswell, 2013a).

Thematic Analysis was initially characterised as a poorly defined, little-known, but commonly applied qualitative analytic technique within psychology. Recently, thematic analysis has gained recognition as a legitimate technique for finding, analysing and reporting patterns (themes) within data sets. It groups and describes data in detail, and frequently goes beyond this to interpret different facets of the research data (Clarke & Braun, 2016; Joffe, 2011).

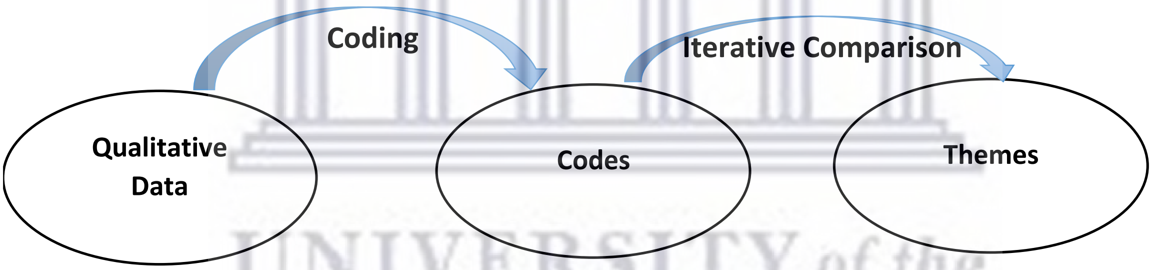


Figure 4-3: Thematic Analysis process. (Source: adapted from Braun & Clarke, 2006)

For this study, a thematic analysis as shown in Figure 4-3 was used to identify themes or patterns in the data that are important or interesting, and that could be used to address the research question. There are three loosely clustered different approaches to TA. Each has different processes and assumptions: Approaches oriented around coding reliability- a small q approach; Approaches based on a structured codebook and qualitative philosophy; and a reflexive approach based on organic coding A Big Q Approach (Hayes, 1997).

There are many different interpretations of thematic analysis. It is more likely that both thematic analysis and grounded theory (GT) were influenced by or developed from content analysis. Although there were several early variations, thematic analysis as a qualitative method only became popular in the 1990s. In its early phases of development, thematic analysis was frequently compared to phenomenology, and this comparison still holds today (Braun & Clarke, 2006). Coding reliability, reflexive analysis and codebook analysis are the three main thematic analysis techniques that now dominate, according to (Braun & Clarke, 2019).

- Code reliability thematic analysis is a deductive (theory-driven) approach that includes familiarisation, theme development, coding (development of coding frame) and testing the reliability of the coding frame (Boyatzis, 1998).
- Reflexive thematic analysis is an inductive (data-driven) approach that includes familiarisation, coding (organic and subjective; one coder) and theme development (review initial themes against coded data and entire dataset; subjective and interpretive).
- Codebook thematic analysis encompasses approaches like framework analysis, template analysis and matrix analysis. Structured codebook or coding frame (like coding reliability thematic analysis) and qualitative philosophy (like reflexive thematic analysis) is used. Some or all the themes are determined in advance or in the early stages of analysis. Coding is a process of organising data into these themes (Braun & Clarke, 2019).

Qualitative data are non-numerical data that have not been quantified. They result from the collection of non-standardised data that require classification and are analysed using conceptualisation (Saunders et al., 2007). Coding is a key process in most qualitative data analysis strategies, but it is sometimes accused of fragmenting and decontextualising text (Bryman, 2015). A code is a word, phrase, or sentence that represents an aspect(s) of a data set that captures the essence or features of data (Adu, 2019).

The process of data analysis and data collection is necessarily an interactive one. Several aids might be used to help through the process of qualitative analysis, including interviews, observations, document and interim summaries, self-memos and maintaining a researcher's diary (Saunders et al., 2007). Thematic Analysis can be carried out in a variety of ways because, unlike most other qualitative analytic procedures, it is not constrained by any one theoretical paradigm within a qualitative model. Thus, thematic analysis can do inductive or deductive/theory-driven data coding and analysis, an experiential or critical orientation to data and a critical realist, contextualist or constructionist theoretical perspective (Clarke & Braun, 2016). The majority of qualitative data types, including those from interviews and focus groups, qualitative surveys, diaries, narrative completion, secondary sources and data produced using creative and visual means, can be analysed using TA. It can be applied to a variety of participatory approaches, pluralist plus mixed methods design, ethnography and other approaches. Thematic analysis can be used to answer the majority of qualitative research questions, including those about social processes, influencing factors, cultural laws and norms, representations and constructions, as well as those about the experiences, practices and sense-making of participants (Taylor & Ussher, 2001).

TA can be used for simple analytical options like "describes," "summarise," "give voice to," and "interpret". Thematic analysiscan also be used for more complex analytic possibilities to tell a story and locate data/participants within the wider social, and for cultural historical, political and ideological contexts; interpret; give a theoretical/conceptual analysis (including theorising relationships); and make an argument. Due to thematic analysis's theoretical adaptability, reflexivity is essential for its effective use. The researcher actively chooses what to do and the study examines the presumptions guiding their interpretation of the data. The researcher must avoid making unacknowledged assumptions by using thematic analysis with awareness and reflexivity (Braun & Clarke, 2013).

Looking for patterns of meaning in the data sets of stakeholders who are small-scale farmers enabled us to make sense of the subjects investigated in the research. The objective was to learn about the participants' perspectives, viewpoints and experiences on the economic, political, and social challenges that affect small-scale farmers' AVCs' use of digital technology. The purpose of TA as an exploratory technique was to better comprehend people's experiences, viewpoints and opinions. This was done to validate the framework for a digital value chain that had been designed to help new small-scale farmers use digital technology for their AVCs. Thus, to conduct a thematic analysis, this study used the six-phase framework suggested by Braun and Clarke (2006). These phases were familiarisation with the data, initial coding, generating themes, validity plus reliability of themes, defining and identifying themes and interpretation plus reporting.

4.8.4.1 Familiarisation of Data

After conducting the interviews that included thirteen (13) audio recordings, data were transcribed and cleaned to prepare it for the data analysis process. This was done by listening to the recording and transcribing what was being said. The transcripts were read many times over and according to Braun and Clarke (2006), this is necessary for researchers to immerse themselves in the data and familiarise themselves with the depth and breadth of the content.

Notes were made on early impressions and holistically, sense was made of the data. Data were classified and categorised repeatedly to allow for deeper immersion in categorising raw data into preliminary groupings or themes.

4.8.4.2 Initial Coding

A part of the data that pertains to or exemplifies a fascinating feature of the research topic is coded. When necessary, in-person coding is offered to help streamline the research and focus it on specific aspects of the data. Instead of using unstructured data, research now develops concepts about what is happening in the data (Morse & Richards, 2002). The foundation for the qualitative analysis stage was laid at the stage of coding, which was a key initial step. A code label was used to describe the content in order to create and assign codes to categorise data extraction. These codes were then used to conduct a thematic analysis. The coding and analysis occurred simultaneously. Coding was used to identify and group similar types of data, which facilitated the study and ensured the validity of the data.

The study used concept-driven deductive coding to apply some pre-established codes to the data set. No matter what is found in the data, the data set is exclusively coded using these codes. However, inductive coding that operates in reverse was used because it was possible that some crucial information could have been missed because of the predefined focus. Some new codes may also appear from the data when the data is examined more closely. By determining what is important and excluding anything that is not related to the study objectives or goals, inductive coding enables one to examine one's data more deeply (Adu, 2019). The type of coding employed was the hybrid technique, which combines the inductive and deductive approaches. This study used a set of codes that were in line with the characteristics of small-scale farmers' resilience (deductive approach). When analysing the data using inductive reasoning, the study added some new ones. This occurred as a result of the code set's inability to adequately capture the depth of the qualitative data.

4.8.4.3 Generating Themes

In TA, a theme is a fully developed shared meaning backed by the central idea of a data set. It has several facets and tells a story to describe the data. Themes might appear early from direct coding, or they can appear later and be the outcome of coding. Theoretically, themes are typically thought of implicitly as previously existing elements that the researcher simply discovers or unearths in the data. The researcher is seen reflexively as actively forming the themes. Themes are produced as a result of the interaction between the data and the researcher's interpretive frameworks, background information, expertise and presumptions, to mention a few. (Braun & Clarke, 2019). A theme is the arbitrary interpretation and culturally specific message of the data. Since concepts do not arise from data completely formed, an active and interpretive process was utilised to generate the initial themes. With the aid of thematic maps and tables, the coded data were examined to find prospective topics. The codes were checked to see if they unambiguously corresponded to a primary topic. Important major codes received theme promotion, and related codes were grouped. A name and a succinct explanation were given to a group of related codes. Code sets not yet assigned, were meaningfully arranged, extracted and assigned to subthemes or a new theme was created.

A theme is the arbitrary interpretation and culturally specific message of the data. A theme is a scarlet thread of underlying meanings that allows similar pieces of data to be connected and allows the researcher to provide an explanation for 'why' (Braun & Clarke, 2006). The relationships between the themes were examined to comprehend the whole story. Themes were carefully chosen to stand out and contribute to the bigger picture. For the following stage, all the coded information pertinent to each subject was acquired.

4.8.4.4 Validity and Reliability of Themes

Themes need to flow naturally and be distinct from one another. At this stage, eliminate themes, group themes collectively and choose subthemes. The researcher ought to be well aware of the various themes at this point, as well as how they interact and what the data's overarching narrative is (Braun & Clarke, 2006).

When examining preliminary themes, it was necessary to determine the type or character of each potential issue to determine whether it was a theme, the quality of the theme, its boundaries, the amount of (useful) data needed to support the theme and whether the data were too diverse and broad-ranging. The themes were examined in connection to both the complete dataset and the coded extracts. When the thematic map was finished, some themes were re-aligned to meet the requirements.

4.8.4.5 Defining and Naming Themes

Identifying the "essence" of what each theme is about is the goal of this final iteration of the themes. It is about writing a thorough analysis of each theme, recognising the story that each theme told and considering how each theme complemented the broader narrative about the full data set in connection to the research objectives (Braun & Clarke, 2006).

When renaming the themes, it must be catchy and convey to the reader what the theme is about right away. A lone researcher may seek advice from outside professionals to assess whether the themes are sufficiently extensive and clear (King, 2004).

Themes were given names or labels when they were defined and named. One-word theme names and names resembling domain summaries were avoided. For each theme, a definition and brief overview were created. The specifics of each theme and the overall story of the analysis were then refined. Themes were organised around a central concept, while each sub-theme highlighted and captured a key aspect of a theme.

4.8.4.6 Interpretation and Reporting

Results from the qualitative analysis in Chapter 6 serve as the study's conclusion. Participants' direct quotes were used in the study because, according to King (2004), they are a crucial aspect of the final report. The literature can be used to support the research findings, as well as give readers a chance to question and expand upon them (Tuckett, 2005).

Producing the report represented the final chance for analysis that consists of analytic commentary, data extracts and themes. A decision was made on the order in which to present themes. Each theme was illustrated using vivid and compelling examples of the data. The analysis was finally related to the research question and the literature.

4.8.5 Qualitative Data Validation

It is critical to understand the key distinction between a research method and a research design. These technical terms are used as criteria for assessing research reliability, validity, replicability and validity types (measurement, internal, external, ecological). It is also necessary to understand the distinctions between the five major research designs discussed: experimental, cross-sectional, longitudinal case study and comparative (Bryman, 2015).

Secondary data sources must be evaluated to ensure their overall suitability for the research questions and objectives to safeguard that the results are valid and reliable. It is important to note measurement validity and data coverage (Saunders et al., 2007). Internal validity in non-experimental research can be jeopardised in a variety of ways (Bryman, 2015).

Table 4-10: Six major extraneous variables that can jeopardise internal validity

History	History effect occurs when some change other than the experimental treatment occurs during an experiment that affects the dependent variable.
Maturation	Maturation effects are a function of time and the naturally occurring events that coincide with growth and experience.
Testing	Testing effects are a nuisance effect occurring when the initial measurement or test alerts or primes participants in a way that affects their response to the experimental treatments.
Instrumentation	Instrumentation effect is a nuisance that occurs when a change in the wording of questions, a change in interviewers, or a change in other procedures causes a change in the dependent variable.
Selection	Selection effect refers to the sample bias from the differential selection of respondents for experimental groups.
Mortality	Mortality effect (sample attrition) occurs when some participants withdraw from the experiment before it is completed.

(Source: Adapted from Zikmund et al., 2013)

Subject error, time error, and observer effects are the main threats to the reliability and validity of structured observation. Prior to collecting data, all questions should be pilot tested to determine their validity and likely reliability (Saunders et al., 2007). Internal validity exists when an experimental variable is truly to blame for any variation in the dependent variable. A manipulation check is a validity test of experimental manipulation to ensure that it produces differences in the independent variable (Zikmund et al., 2013).

The six major extraneous variables that can jeopardise internal validity are presented and explained in Table 4-10. History, maturation, testing, instrumentation, selection, and mortality are the variables. The following conditions must be met while doing quality assurance for the qualitative research analysis phase to verify the results' dependability, credibility and transferability.

- Credibility requires confirming data accuracy, direct connection, context richness and triangulation using multiple data sources to accurately represent participants' experiences.
- Transferability requires well-defined context and well-articulated research assumptions for accurate application in similar situations.
- Followed methods ensure identical reliability, clearly defined procedure, paradigm, researcher role, bias and background, ensuring clear and accurate data analysis.

(Trochim, 2006; Yilmaz, 2013).

4.9 Collection and Analysis of Data

The act of gathering information passively or receptively is known as data collection. A hypothesis or the researcher's preconceived beliefs may compromise the veracity of data from a phenomenon. In contrast, the research process starts with the discovery of a conceptual or empirical problem (Mouton, 1998). Data collection and analysis are determined by the methodology employed (Bryman, 2015). The approach adopted at this point in the study makes a substantial contribution to the study's overall validity and reliability (Saunders et al., 2007). Whatever the project's methodology, two categories of data can be distinguished: primary and secondary.

To better describe and comprehend the links and dynamic features of the social context in which D4D interventions take place is by combining qualitative and quantitative methodologies (Ospina & Heeks, 2016). Sequential explanatory mixed techniques, which consist of two distinct integrated phases, were employed in this investigation. The collection and analysis of quantitative data comes first, followed by the sequential gathering and analysis of qualitative data in the second phase, which defines the sequential explanatory mixed methods design. The study's second qualitative phase aids in the explanation or expansion of the first phase's quantitative findings. The study's quantitative phase assisted in providing "what" answers, while the qualitative phase assisted in providing "why" answers about participants' perceptions of the adoption of digital technology in small-scale farmers' AVCs.

Small-scale farmer surveys were combined with interviews to acquire data. To determine the economical, institutional and political situations in the area, a baseline survey was initially carried out utilising trend/historical lines and interviews with groups and key informants. The sampling size and questionnaire design were chosen based on the outcomes of the baseline survey. To give us an overview of digital penetration, secondary data were initially looked at using a literature review. Next, survey research and analysis are used to look into how small-scale farmers can adopt digital technology in their AVCs in South Africa. Based on how this connects to the more general study aims, conclusions are reached.

4.9.1 Primary Data

Information gleaned from first-hand sources is referred to as primary data. Material may be from first-hand accounts of the past or information gathered from survey or interview participants (Bryman, 2015; Kothari, 2004). The information does not need to come from the research that is being done. Similarly, data gathered from other academics can be displayed as text or used as primary data (Flick, 2011). As a result, rather than through the prism of another study, the source data is best understood as the data being studied as a whole.

Primary data is obtained by interacting with people in a personal or impersonal way. An experiment or survey can be used to acquire this data. The researcher must consider the nature of the investigation, the purpose and scope of the inquiry, financial resources, available time and the required level of accuracy while selecting data collection methods (Kothari, 2004). Due to time and money restrictions, this project is impossible to acquire primary data utilising the Participatory Action Research (PAR) method. A PAR strategy is recommended for gathering primary data for additional research.

4.9.2 Secondary Data

Using the findings or viewpoints of other academics, secondary data is information that is not primary data. Since they represent material that has already been processed by another, the results of a study article, for instance, are regarded as secondary data. A similar distinction can be made between statistical survey analyses and secondary data (Kothari, 2004). The data is defined, however, more by its use than by its fundamental characteristics. Newspapers can be used as a primary or secondary source of information, depending on whether the reporter was on the scene (Flick, 2011).

4.10 Integration of Results

Theories are simply generalisations that aid in understanding reality. Furthermore, theories enable an understanding of the logic behind what is observed. If a theory does not hold in practice, it is meaningless (Zikmund et al., 2013). Meta-inference is the process of combining the results of both quantitative and qualitative research (Venkatesh et al., 2013). The results from the quantitative and qualitative analysis were insightful and rich when data were compared before being integrated to develop meta-inferences (APPENDIX I).

Positivism is the philosophical position of the natural scientist. This entails working with an observable social reality, and the outcome can be law-like generalisations like those found in the physical and natural sciences (Saunders et al., 2007). A concept is a broad idea that represents something meaningful. It is a generalised idea about a class of objects that has been given a name, and it serves as the basic unit for theory development as an abstraction of reality

(Zikmund et al., 2013). The triangulation of diverse findings from qualitative and quantitative stages led to a thorough knowledge of the phenomenon of digital technology adoption in AVCs of small-scale farmers. Results from the qualitative phase were compared with outcomes from the qualitative phase as part of the technique triangulation. The integrated framework helped to achieve sufficient design for the validity and reliability of quantitative data, as well as the credibility of qualitative data (Venkatesh et al., 2013).

Vague plans and abstract ideas need to be transformed into concrete statements using qualitative data, as statistical generalisations cannot be generalised to the population (Zikmund et al., 2013). Mixed methods research uses interpretive meta-inferences, integrating findings from both qualitative and quantitative aspects, allowing for the triangulation of data from multiple methodologies (Venkatesh et al., 2013).

The meta-inference bridging procedure in this study combines quantitative and qualitative conclusions in a sequential explanatory mixed-methods study, enabling in-depth theoretical understanding and conclusions that cannot be achieved with a single method.

The integrative framework, according to Venkatesh et al. (2013), enhances the rigour of the integration of the results and inferences of the mixed methods research by successfully integrating into theoretically consistent meta-inferences, meta-inferences satisfy the initial purpose of conducting a mixed methods research, and meta-inferences are generalisable to other contexts and settings. It is not a given that the results of qualitative and qualitative research findings agree when there is integrative efficacy.

4.10.1 Generalisation Comparing Qualitative and Quantitative Research

The basic research report will focus more on how the current research is integrated into previous literature on the research topic. This section concludes with a set of theoretical hypotheses. Single-sources data-Integrated Information are various types of data that are typically combined based on a common variable (Zikmund et al., 2013). To provide readers with a better understanding of the mixed-methods research project, the findings from the quantitative and qualitative phases are combined. The qualitative interview step helped to clarify the quantitative findings. Based on the quantitative findings, the participants for the qualitative phase were chosen from those who satisfied certain requirements. Descriptive data, such as significant differences between groups, were included in the quantitative results that were utilised to choose individuals for the second qualitative phase.

Table 4-11: Generalisation Comparing Qualitative and Quantitative Research

Qualitative Research	Research Aspect	Quantitative Research
Discover Ideas, Used in Exploratory Research with General Research Objects	Common Purpose	Test Hypotheses or Specific Research Questions
Observe and interpret	Approach	Measure and Test
Unstructured, Free-Form	Data Collection Approach	Structured Response Categories Provided
Researcher Is Intimately Involved. Results Are Subjective	Researcher Independence	Researcher Uninvolved Observer. Results Are Objective.
Small Samples—Often in Natural Settings	Samples	Large Samples to Produce Generalisable Results (Results That Apply to Other Situations)
Exploratory Research Designs	Most Often Used	Descriptive and Causal Research Designs

(Source: Adapted from Zikmund et al., 2013)

In Table 4-11, the findings from the quantitative research fed the qualitative investigations, as the goal of performing mixed methods research was to achieve completeness. Due to the additional insights from both quantitative and qualitative research, the mixed methods study served to confirm and expand the phenomenon of interest (Creswell, 2009; Teddlie & Tashakkori, 2009). The justification for utilising mixed methods research is that if the combination has complementary strengths and non-overlapping weaknesses, the quantitative and qualitative phases will balance out each other's drawbacks (Johnson & Turner 2003). The mixing of qualitative (in-depth interviews) and quantitative (questionnaires) data yields complete results to make better inferences about digital technology adoption in AVCs of small-scale farmers. Note that diversity of opinion in mixed methods is welcome as it reflects different voices and perspectives on digital technology adoption in AVCs of small-scale farmers (Teddlie & Tashakkori, 2009).

Thus, scientific enquiry has two fundamental levels, empirical and abstract. The empirical aspect is primarily concerned with scientific facts as revealed by observation and experimentation. The abstract or theoretical aspect, on the other hand, consists of a serious attempt to understand scientific facts and integrate them into a coherent, logical system. The basic laws of science are derived, directly or indirectly, from these observations and integrations (Zikmund et al., 2013).

The combination of in-depth interviews (qualitative) and questionnaires (quantitative) data produces full results to draw more accurate conclusions. A variety of opinions in mixed methods is encouraged since it reflects various viewpoints and voices on digital technology adoption in AVCs of small-scale farmers (Teddlie & Tashakkori, 2009).

4.10.2 Validating Mixed Methods Research

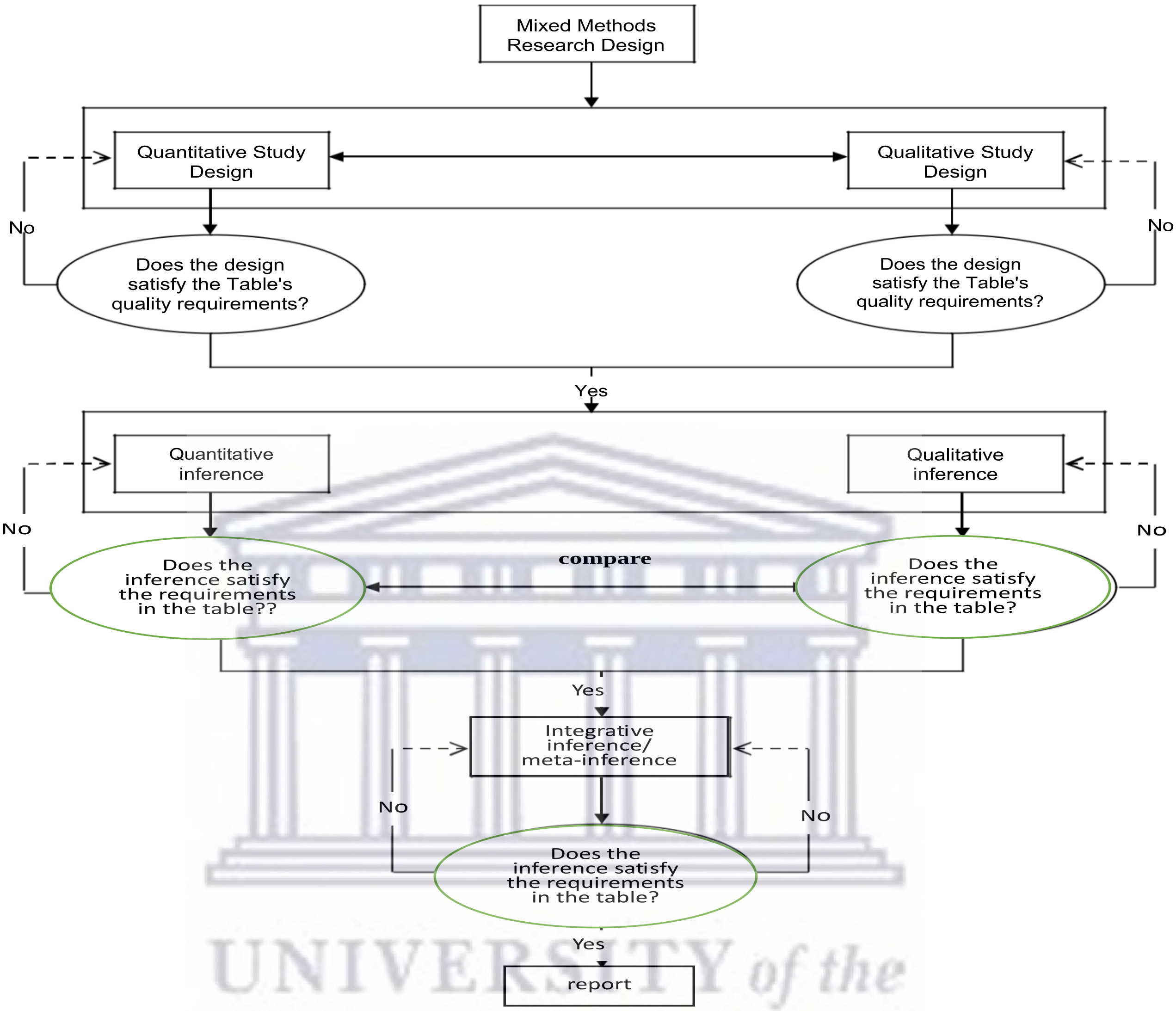


Figure 4-4: An Integrated Framework to validate Mixed Methods research. (Source: Adapted from Venkatesh et al. 2013)

There are numerous approaches to combining quantitative and qualitative research and representing mixed methods research. The results of combining quantitative and qualitative research can be either planned or unexpected. While the use of mixed methods research has increased, not all authors agree with it. Opponents of mixed methods research typically argue that there are epistemological and ontological barriers to combining quantitative and qualitative research (Bryman, 2015).

This study uses an integrated framework as shown in Figure 4-4 that can assist digital development research to validate mixed methods research developed by Venkatesh et al.

(2013). The integrative framework offers guidance for doing high-calibre mixed methods research and generating meta-inferences by inferring from both quantitative and qualitative strands. Comparing, contrasting, incorporating, tying together and integrating the findings from the two methodologies is how qualitative and quantitative studies are integrated. Via the independent validation of quantitative and qualitative investigations before mixed methods meta-inferences, the integrative framework offers a comprehensive understanding of the integrative inferences.

Before the mixed methods validation, the quantitative and qualitative validations were carried out independently. Validation of mixed methods research includes evaluating the accuracy of conclusions drawn from both qualitative and quantitative research. Establishing the reliability of the mixed-methods quantitative and qualitative strands is one of the integrated findings conclusions (Maxwell & Loomis, 2003). The use of mixed methods research enhances reliability via triangulation and a more detailed description of the phenomena. Consequently, the advantages of mixed methods research in producing original knowledge and contributions cannot be contested. The biggest challenge for mixed methods research is that it requires more knowledge and resources to be successful. The quality and rigour of the research was enhanced via qualitative and quantitative validation. The quantitative validation process and principles have sufficiently developed in comparison to qualitative validation, which lacks a broad consensus on methodologies and principles (Venkatesh et al., 2013).

The stringent standards of both qualitative and quantitative research served as the foundation for the data analysis in this study. The examination of the data using a combination of quantitative and qualitative methodologies was crucial for drawing valid conclusions from the study. Based on the research questions and objectives, quantitative and qualitative data were analysed. Developing good quality meta-inferences required careful consideration of both the qualitative and quantitative data's quality.

Before discussing the validity of the meta-inferences, the validity of the qualitative and quantitative strands was individually discussed as part of the design, analysis and findings. Design validity, measurement validity and inferential validity were all included in qualitative validation. By establishing a common language for research, the topic of qualitative validation contributed to closing the gap between qualitative and quantitative worldviews. This Integrated Framework developed by Venkatesh et al. (2013) is further explained using a table (see APPENDIX I).

The key validation concerns are related to the validity and reliability of quantitative phase measures because they are a component of summative and formative validity (Tashakkori & Teddlie, 2010). A prerequisite for the validity of quantitative research is measurement reliability. The research findings based on measurement, design and inferential quantitative research were made more credible by validity (Maxwell & Loomis, 2003; Teddlie & Tashakkori, 2009, 2009). The three kinds of validity improved statistical conclusion validity, internal and external validity and content and construct validity.

In contrast to quantitative research, qualitative research does not have established acceptable validation standards. It has been determined that qualitative research does not lend itself to reliability-based quantitative validation (Guba & Lincoln, 2005). Yet, scholars generally agree that validation is significant in qualitative research. In qualitative research, some researchers prefer the terms dependability and consistency since they sound close to reliability (Teddlie & Tashakkori, 2009).

In qualitative research, descriptive, interpretative and theoretical validity have been proven to be appropriate and adequate to demonstrate dependability. In the quantitative research approach, theoretical validity resembles analytical validity, interpretative validity resembles inferential validity and descriptive validation resembles design validity (Maxwell & Loomis, 2003; Teddlie & Tashakkori, 2009).

Rigidity is important for how well a quantitative study was planned and carried out (design validity), how well qualitative data were gathered and evaluated (analytical) and the quality of the interpretation (inferential accuracy). Several scholars claimed that competent application of the methodology, interpretation of data, data collecting, and analysis constitute rigour in qualitative research (Guba & Lincoln, 2005). In both quantitative and qualitative research, some researchers choose a rigorous approach to validity (Tashakkori & Teddlie, 2010; Maxwell & Loomis, 2003). Following the discussion of integrating the results, the study's ethical implications are covered in the next section.

4.11 Ethical Consideration

The focus of ethics is on moral issues that come up during data collection and analysis in the context of interactions between researchers and research subjects. Participant harm, a lack of informed consent, breach of privacy and deception are the key ethical issues (Bryman, 2015). It is feasible to conduct cross-sectional or longitudinal research initiatives. To guarantee the validity and dependability of the results, steps must be taken. Think about the access and ethical concerns the research design raises (Saunders et al., 2007).

The rights of study participants are the primary focus of ethical standards; nevertheless, the lines separating ethical and unethical actions are not always apparent because issues regarding professional self-interest are also highlighted (Bryman, 2015). Axiology is the study of how ethics and morals play a part in scientific enquiry. This covers issues such as how researchers handle their values, as well as the values of study participants. Research design must always consider the accessibility and ethical concerns that are raised (Saunders et al., 2007).

It can be challenging to separate ethical problems from poor-quality research problems. At various stages of an investigation, there are political aspects to the research process that are concerned with the role and exercise of power (Bryman, 2015). Access negotiations and research ethics are essential aspects of research. To better understand the issue of gaining entry, different types and levels of access have been identified. These include physical access to an organisation, access to intended participants, ongoing access to conduct additional research or repeat data collection in another area of the organisation, and cognitive access to get close enough to find accurate and reliable data (Saunders et al., 2007).

Research topics and methods are often chosen based on their practicality. Research ethics refers to the suitability of the researcher's actions considering the rights of those affected by the work. Possible ethical problems must be recognised and considered from the outset of the study, and they ought to be one of the factors taken into consideration while judging the research proposal. At every stage of the research effort, including data gathering, analysis and reporting, ethical issues are likely to come up. The "power dynamic" between the researcher and those who offer access is related to ethical issues as well (Saunders et al., 2007).

The relevance of this component of research has increased with the adoption of data protection legislation, and researchers must now carefully adhere to several legal obligations to preserve the privacy and interests of their data participants (Saunders et al., 2007). Ethics is the study of how moral principles should be applied to behaviour. Moral standards are principles that represent opinions about what is morally right and wrong. When faced with a decision between two options, each of which has various ethical ramifications, the situation is said to be an ethical dilemma. Advocacy research is done to support a specific legal contention or to advocate for an advocacy group. Good ethics generally align with the concept of "right," whereas bad ethics align with the concept of "wrong."

4.11.1 Applying ethics to the current research.

Each participant in a study has privileges and duties. They are generally interrelated in that the exercise of one party's rights frequently results in obligations for other parties. All parties have rights and responsibilities, but the researcher has a specific duty to safeguard research participants. Participants in studies may occasionally suffer injury as a result of manipulation.

This study made sure that the highest ethical standards were upheld and that the researcher had received the necessary instruction and preparation before beginning the investigation. The researcher tried, among other things, to assure factual correctness and prevent data falsification, fabrication, suppression or misinterpretation. This was accomplished by properly citing concepts and data sources while double-checking with the supervisor.

All knowledge, ideas and research methods used in this study were properly acknowledged. Also, the research subjects' rights, welfare, identity and interests were protected, and the study's findings did not violate their privacy or other rights. All participants gave their consent when required and did so voluntarily. They had the right to withdraw from the study at any time. The material generated was kept confidential and anonymous, and the research was done in conformity with all ethical and professional standards.

The researcher was prepared to properly explain the research's genuine goal to the participants during a debriefing. Additionally, the researcher prevented volunteers from suffering unwarranted bodily or mental harm. An effective strategy to prevent a conflict of interest was to steer clear of several initiatives with competing research interests. Access to small-scale farmers was requested from several institutions that deal with them regularly. Participants were given the assurance of confidentiality because transcripts, notes and audiotapes were kept in a location that could be locked, and participant names were masked. Forms requesting their consent were signed by participants before the interview. Prior to beginning the data collection process, the University of the Western Cape provided ethical clearance. The study's scope and limitations are explored in the next section after the ethical issues of the investigation have been covered.

4.12 Scope and Limitations

This study had many shortcomings that could be ascribed to time and resource limits. Since secondary data are few in this area of research, only primary data were used for analysis. Finding reliable information on D4D application in AVCs of small-scale farmers was challenging due to the lack of research in this area.

This study concentrated on two district municipalities in Western Cape Province due to Covid-19 restrictions that led to lockdowns and a shortage of resources. It was very difficult to persuade participants to volunteer for the study. Due to the study's focus on these two districts rather than other provinces or districts in South Africa, it is possible that its findings cannot be generalised to other areas.

The research's findings apply to districts and small-scale farmers' AVCs, offering the potential for further study. The diverse participants and case studies enhance the data's depth, but case studies may hinder generalisation. Zikmund et al. (2013) emphasise the challenges encountered when attempting to generalise case study research findings to other situations.

The intention of qualitative analysis for this type of research is to use a Participatory Action Research (PAR) method for research in this area. Such a study would be conducted over time to track the progress of these small-scale farmers and how D4D projects can help farmers become more economically and environmentally sustainable. The implications of the research are covered in the next section once the limitations of the study have been addressed.

4.13 Implications of the Research

Academics have come under fire for prioritising technology accuracy over what is relevant while doing D4D research to develop AVCs of small-scale farmers (Lee, 2004). The argument has been made that the most rigorous research is inadequate to address the complex, non-quantifiable problems that challenge digital technology adoption in AVCs of small-scale farmers. Conventional statistical analysis-based scientific approaches are unable to handle complex D4D decisions based on partial data (Teddlie & Tashakkori, 2009).

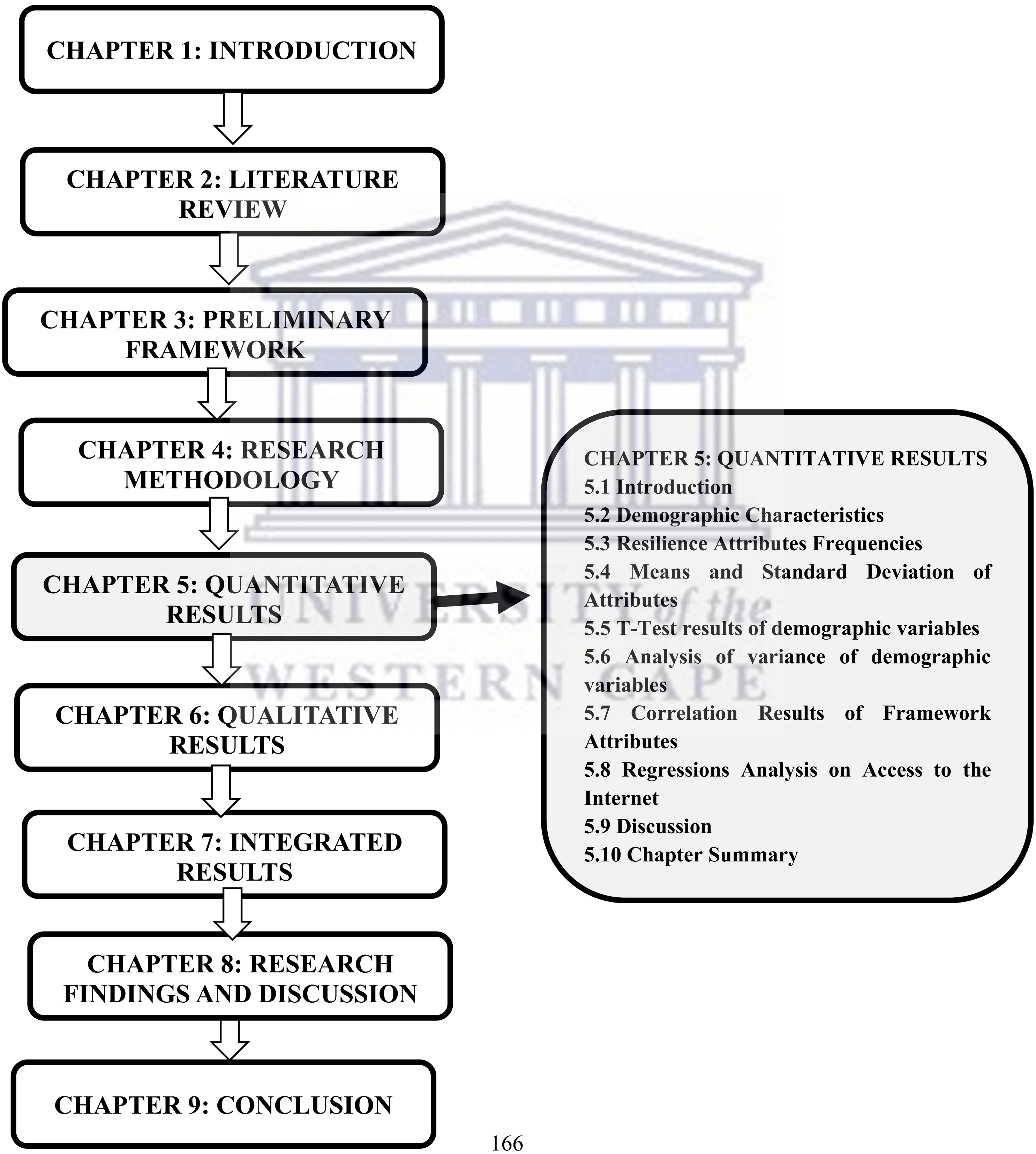
The research's usefulness lay in its capacity to address the complicated and intangible realities of the Industry 4.0 world (Adeoti, 2019; Fonseca, 2018). Due to the researcher's ability to interact with participants, the research was able to accomplish both relevance and rigour in business research. The intricate, unquantifiable business challenges were thoroughly recognised.

D4D researchers aim to create accessible, rigorous research for practitioners, addressing the need for small-scale farmers to adopt digital technology in AVCs. The study's findings will aid in successful interventions and contribute to existing knowledge on D4D.

4.14 Chapter Summary.

The literature review emphasizes the significance of small-scale agriculture for food security, safety, and employment, reducing poverty and inequality. It suggests that digital technology adoption in AVCs is crucial for small-scale farmers, particularly among rural poor people. However, insufficient research on this topic leaves gaps in our understanding.This chapter discussed the research methodology for validating a digital AVC framework for small-scale farmers in South Africa. It focus on sequential explanatory mixed methods and the research philosophy's role in establishing the study's foundation and design suitability. The research plan demonstrates the pragmatic approach, allowing researchers to bridge paradigms using various data sources and mixed methodologies, and addresses participant selection issues.The study used sequential explanatory mixed methods research for a unique Digital for Development (D4D) research topic. The methodology was essential for determining sample size and addressing validity, credibility, reliability, limits, and ethical consequences. The quantitative phase results were used to verify a preliminary framework for implementing a digital AVC for small-scale farmers in South Africa.

CHAPTER 5: DIAGRAMMATIC OVERVIEW



5 Chapter 5: Quantitative Results

5.1 Introduction

The research technique used to validate the conceptual framework for implementing digital Agricultural Value Chains (AVCs) for small-scale farmers in South Africa was covered in the preceding chapter. The argument for employing mixed methods research to confirm the digital AVC framework's applicability for responding to the study questions was also underlined in the prior chapter. This chapter shows the quantitative results from the survey data gathered from the study's small-scale farmer stakeholders. The chapter also addresses the quantitative outcomes.

All the small-scale farmers who took part in the study had contact with at least one type of technology. All the chosen participants had taken part in one or more stages of the AVCs of small farmers. The survey's goal was to collect information on the conceptual framework's essential elements to establish a system-wide knowledge of the relationships between development interventions and small-scale farmers' resilience in AVCs. The primary goal was to collect data on how digital technology was used in AVCs. Also, it revealed how the respondents thought a digital AVC framework could promote resilient small-scale farming and thus achieve sustainable small-scale agriculture development.

Digital technology can have a significant impact on how resilient rural agricultural livelihoods are to outside stresses to evaluate how digital technologies have helped small-scale farmers in AVCs build resilience. Robustness, self-organisation and learning are the three core foundations of resilience that the survey measures, along with the six secondary enablers of resilience (redundancy, rapidity, scale, diversity, flexibility, equality). Farmers will become more resilient as a result of the use of digital AVCs the stronger these are.

The survey was separated into three sections: interviewee characteristics, access to and perception of digital technology and determining the impact on resilience attributes. As a result, the study was interested in how they perceived the usage of digital technology in AVCs based on prior experiences. The utilisation of digital technology in AVCs serves as the study's dependent variable. The poll gauges respondents' opinions on how to increase AVCs' resilience by employing digital technology.

Part of testing the proposed framework included using the resilience attribute variables of small-scale farmers (see Table 3-3). Pilot testing of the questionnaire was conducted to clarify some of the ambiguous items. The framework's elements were put to the test to determine their relationship to and ability to predict the dependent variable. The preceding chapter covered how the sample size would fit with the planned statistical analysis.

The questions were created using the Likert scale to measure perceptions scientifically. On a 3-point scale, the lowest agree received 1, the middle doesn’t know received 2 and the highest disagree received 3 points. In a different situation, a 3-point scale was employed, with the lowest value strengthening it with 1, the intermediate value not knowing with 2, and the greatest value weakening it with 3 points. In the last scenario, a 3-point scale was employed, with the lowest indicating more with 1, the middle indicating doesn't know with 2, and the highest suggesting less with 3. Following preliminary analysis, the construct's score was determined by averaging the items' (questions') responses. This score was then utilised for various statistics, including means, standard deviation, t-tests, analyses of variance, correlations and regression analysis.

This chapter is organised as follows: section 5.2 presents the demographic data, section 5.3 presents the frequencies of the resilience attribute variables, section 5.4 presents means and standard deviations, section 5.5 presents t-test results, section 5.6 presents the analysis of variance results, section 5.7 presents correlation results of the resilience attribute variables, section 5.8 presents the regression analysis results, section 5.9 presents the discussion of the chapter and finally, section 5.10 presents a summary of the chapter.

5.2 Demographic Characteristics

The demographic data for the respondents—including gender, age and occupation—as well as their use of digital technologies—including if they own a cell phone, how many they own, and whether they have access to the Internet—are shown in Table 5-1. Among the stakeholders who make up small-scale farmers' constituencies, 210 responded to the survey.

Male respondents made up the majority of the sample, 70.6%, while female respondents made up 29.4%. Table 5-1's breakdown of respondents' ages reveals that 5% were between the ages of 15 and 25; 13.1% were between the ages of 26 and 35; 18.8% were between the ages of 36 and 45; and finally, 63.1% were older than 46.

Table 5-1: Sample Demographics (n=210)

Characteristics of the Interviewee			
Variable	**Categories**	**Count**	**%**
Gender	Female	47	29.4
	Male	113	70.6
Age	15 to 25 years	8	5.0
	26 to 35 years	21	13.1
	36 to 45 years	30	18.8
	More than 45	101	63.1
Occupation	Employed	15	9.4
	Retired	29	18.1
	Unemployed	103	64.4
	Other	13	8.1
Digital technologies (access and perception)			
Variable	**Categories**	**Count**	**%**
Own a mobile	Yes	158	98.8
	No	2	1.3
No of many mobiles	0	2	1.3
	1	154	96.2
	2	4	2.5
Access to Internet	Yes	50	31.3
	No	110	68.8

Most respondents had access to a mobile device, but less than a third had access to the internet when it came to access and perceptions of digital technologies. The respondents owned a cell phone in 98.8% of cases, while only 1.3% did not. Just about 96.2% of people had more than one mobile phone, whereas 2.5% had two or more. Although practically all of the respondents had smartphones, only 31.3% of them used the internet. For one reason or another, the remaining 68.8% of respondents do not use the internet.

5.3 Variables Attribute Frequencies

The demographic details of the survey respondents were covered in the section before this one. The frequency distribution of the Resilience Attributes that can assist in framework construction is shown in the following sections. The frequencies are based on the information gathered from the small-scale farmers who took part in the study's questionnaires. The frequency distribution for the resilience attributes is shown next.

The frequency of responses on the Robustness attribute variables is shown in Figure 5-1 above. Many respondents, 57.5%, felt that having access to digital technology was crucial because it gave them better access to emergency information than the few, 3.8% who disagreed and 38.8 percent who did not know.

5.3.1 Robustness Attribute Frequencies

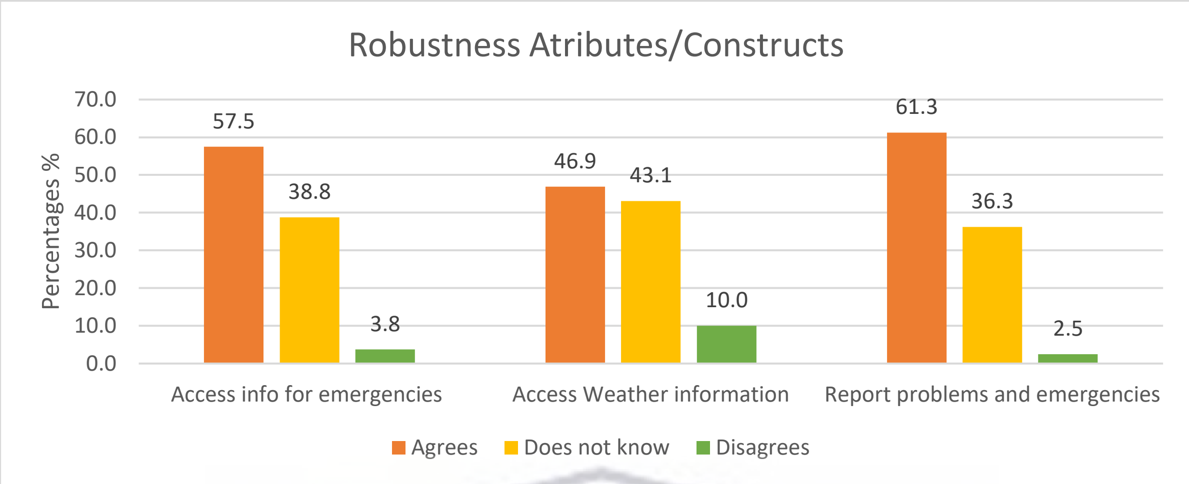


Figure 5-1: Robustness Attribute Frequencies

Many respondents, 46.9%, agreed that digital technologies give them better access to weather information than did the 10% who disagreed or the 43.1% who were unsure.

Digital technologies make it easier to report problems and emergencies, according to most respondents 61.3%, contrasted with the small 2.5% who disagreed, or 36.3 percent that did not know.

The high percentage of respondents who did not know about the aforementioned categories may be attributed to the 68.8% of respondents who do not use or have access to the internet in Table 5-1. This can be significantly reduced with better training and ongoing support for digital technology adoption in AVCs of small-scale farmers.

5.3.2 Self-Organisation Attribute Frequencies

The frequency of responders on the Self-Organisation attribute variables is shown in Figure 5-2 above. Comparatively, 61.9% of respondents agreed that the adoption of digital technology made it simpler to access Agriculture Value Chains (AVCs), compared to 0.6% who disagreed and 37.5% who did not know.

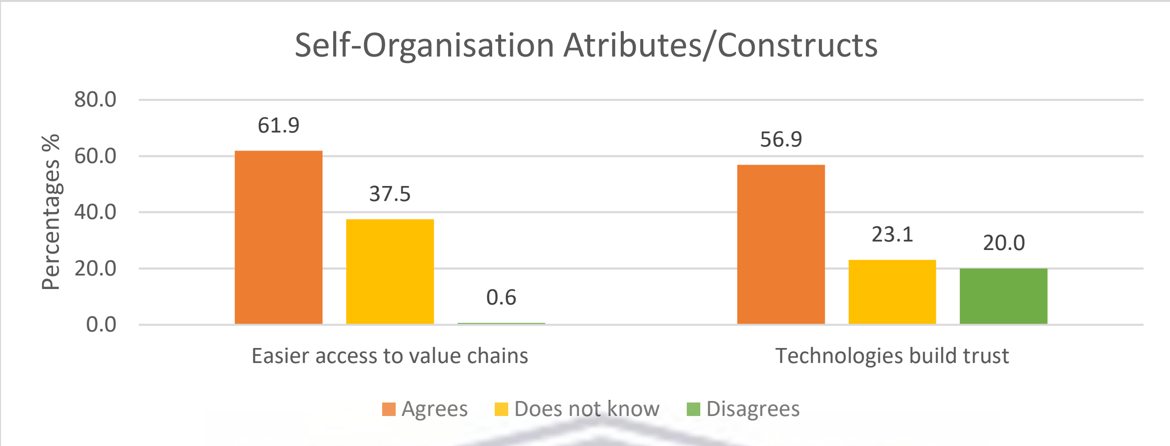


Figure 5-2: Self-Organisation Attribute Frequencies

In addition, around 56.9% of respondents felt that digital technology can help foster trust among AVC stakeholders, as opposed to 20% who disagreed or 23.1% who were unsure.

Similarly, as in the previous category, a high percentage that did not know about the above categories could be due to the 68.8% of the respondents that did not access the internet.

5.3.3 Learning Attribute Frequencies

Frequencies of responses to the Learning attribute variables are displayed in Figure 5-3. Less than half of the respondents, 22,5%, agreed that they had at least once received training via the internet compared to those who disagreed, 42,4%, or did not know, 42,5%.

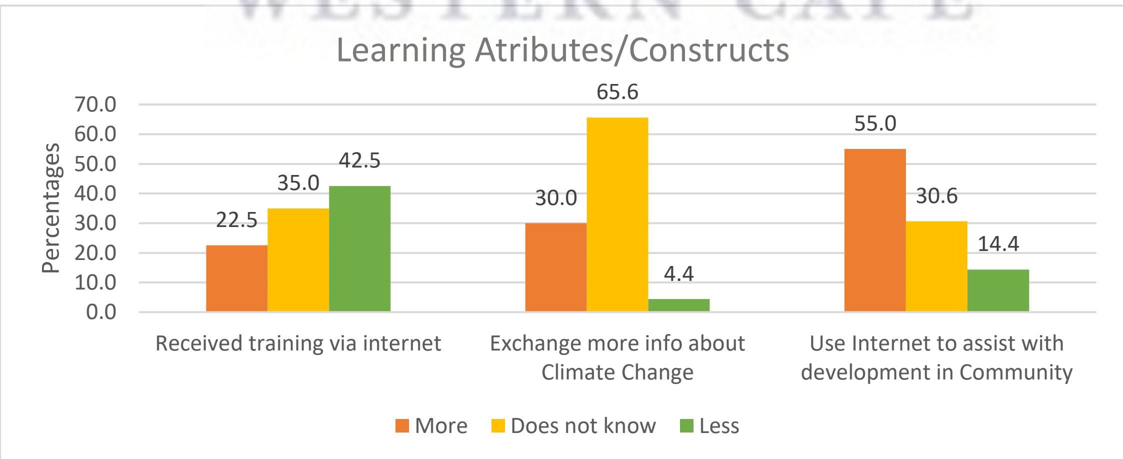


Figure 5-3: Learning Attribute Frequencies

In addition, around 65.6 %, or little under two thirds, were unsure of whether more information is shared about climate change. Almost 30% of respondents agreed that they are provided with more information about climate change, while only 4.4% disagreed.

Almost 55% of respondents, or slightly more than half, agreed that the internet and other digital technologies may help the small-scale farmer community prosper, while 14.4 % disagreed or 30.6% were unsure. The high percentages that did not know about the above categories are 42.5%, 65.6% and 30.6%.

5.3.4 Redundancy Attribute Frequencies

Referring to the Redundancy attribute variables, Figure 5-4 above displays respondents' response frequencies. In comparison to the minority of respondents, 21.9%, who disagreed or the remaining 30% who were unsure, 48.1% of the respondents agreed that digital technology can be employed to earn additional income.

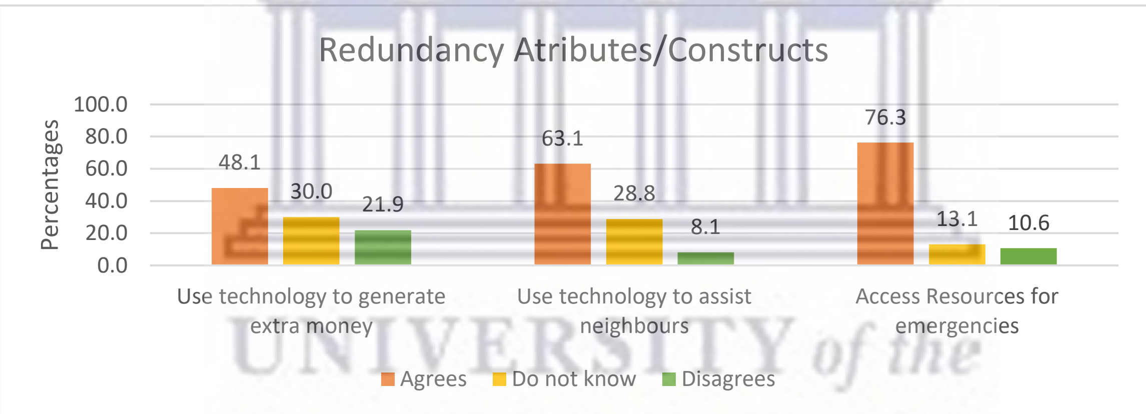


Figure 5-4: Redundancy Attribute Frequencies

Compared to 8.1% of those who disagreed or 28.8% who were unsure, most respondents, 63.1%, believed that they can use digital technologies to help their neighbours in AVCs and emergencies.

In comparison to 10.6% who disagreed and 13.1% who were unclear, 76.3% of respondents agreed that people can more easily get assistance faster following disasters.

5.3.5 Rapidity Attribute Frequencies

The response frequencies for the Rapidity attribute variables are displayed in Figure 5-5 above, as 93.1% of respondents agreed, with no respondents disagreeing that using digital technologies makes it easier to seek emergency relief in the event of a crisis. Just 6.9% of respondents were unsure.

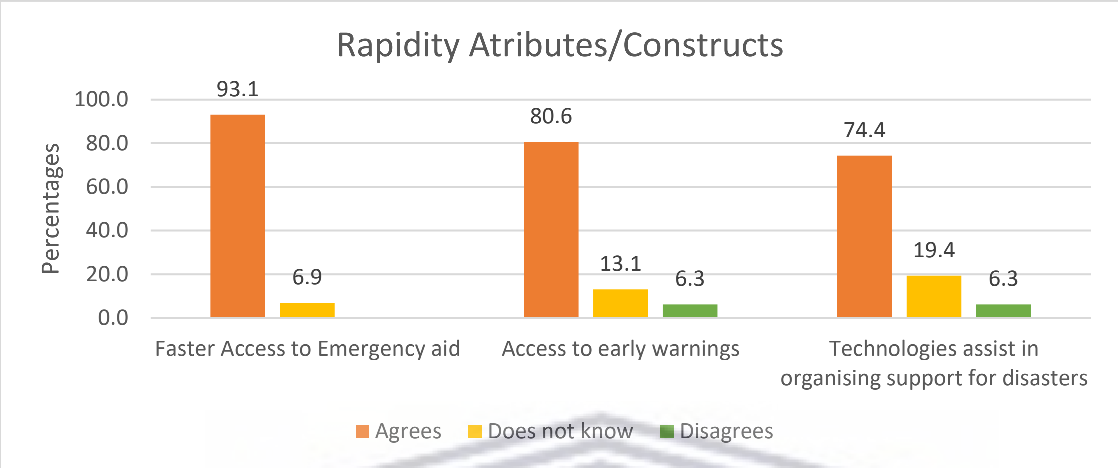


Figure 5-5: Rapidity Attribute Frequencies

In contrast to the 6.3% of those surveyed who disagree and the 13.1% who were undecided, 80.6% of respondents said they use digital technology to access early warning systems for potential disasters.

Compared to 6.3% who disagreed and 19.4% who were unsure, 74.4%, or little under three-quarters, agreed that digital technology can help arrange support for disasters faster.

5.3.6 Scale Attribute Frequencies

The frequency of the Scale attribute variables is displayed in Figure 5-6 above. Many respondents, 46.9%, agreed that using digital technology in groups facilitates communication and collaboration, as opposed to 16.9% who disagreed or 36.3% who were unsure.

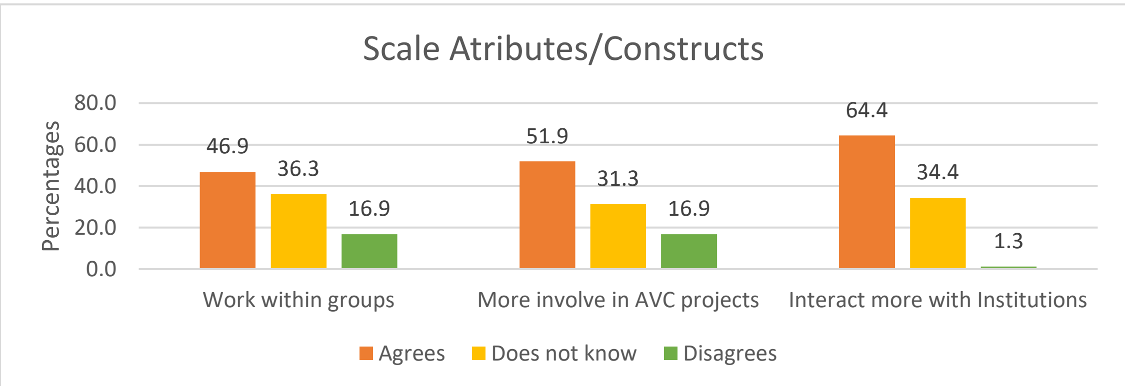


Figure 5-6: Scale Attribute Frequencies

In comparison to 16.9% of those who disagreed and 31.3% of those who did not know, most respondents, 51.9%, believed that digital technologies help them become more active in AVC projects.

Compared to 1.3% of those who disagreed or 34.4% who were unsure, many respondents, 64.4%, believed that digital technology adoption allowed them to communicate more with institutions participating in AVCs.

5.3.7 *Diversity and Flexibility Attributes Frequencies*

No one disagreed, with nearly 93.8% of respondents agreeing that digital technologies increased opportunities in AVCs relative to 6.3% of those who did not know.

Like the previous point, 89.4% of respondents agreed that digital technology encouraged innovation to better livelihoods, compared to 10.6% who were unsure and none who disagreed.

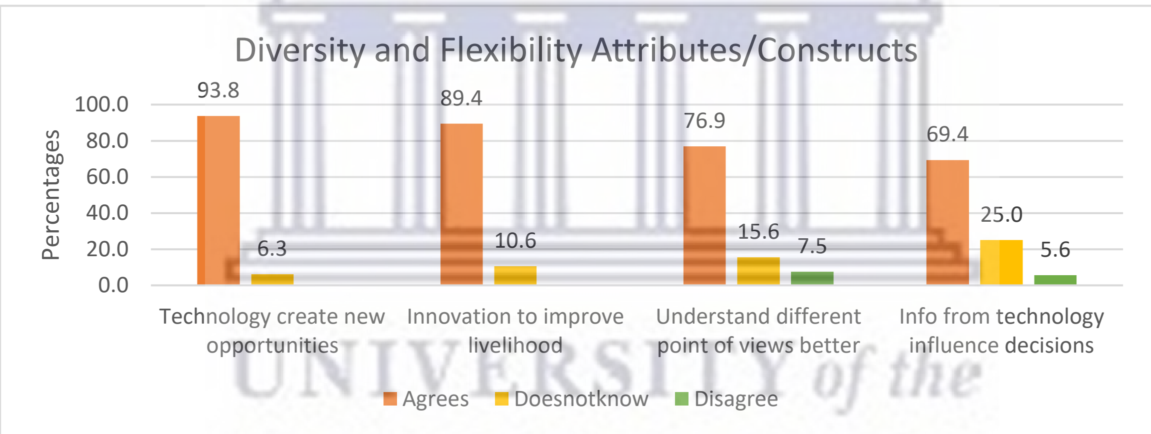


Figure 5-7: Diversity and Flexibility Attributes Frequencies

Most respondents, 76.9%, agreed that the usage of digital technologies helps people understand different points of view better, compared to 7.5% who disagreed and 15.6 % who were unsure.

Compared to 5.6% who disagreed and 25% who did not know, many respondents, 69.4%, agreed that knowledge of new digital technology influences decisions in AVCs.

5.3.8 *Equity Attribute Frequencies*

The frequency of replies for the Equity attribute variables is shown in Figure 5-8 above. In contrast to the 18.1% of respondents who disagreed and the 39.4% who were unsure, most respondents, 42.5%, agreed that Digital for Development (D4D) programmes can assist poorer farmers in catching up with the richer farmers.

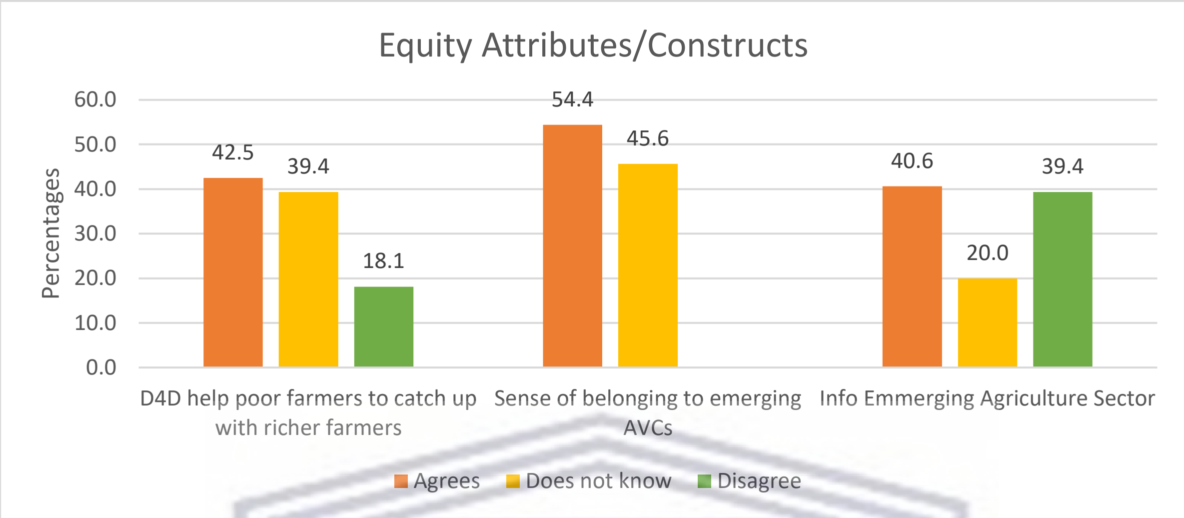


Figure 5-8: Equity Attribute Frequencies

In comparison to the 45.6% of respondents who did not know, a majority of respondents, about 54.4%, agreed that digital technologies give small-scale farmers a sense of belonging to AVCs. None of the respondents disagreed.

In contrast to the 39.4% of respondents who disagreed or the 20% who did not know, a majority of respondents, or 40.6%, agreed that they can use digital technology to educate themselves on initiatives and information in the agriculture sector.

5.4 Means and Standard Deviation of Attributes

All attributes were subjected to a Cronbach alpha reliability test. Since most constructs were above the minimal allowable level of 0.6, the results were considered good. Only one attribute, Rapidity, registered at less than the permitted 0.57. The constructs were assessed after deleting unreliable items before means, standard deviation, T-test, analysis of variance, correlation and regression were conducted (see Table 4-3).

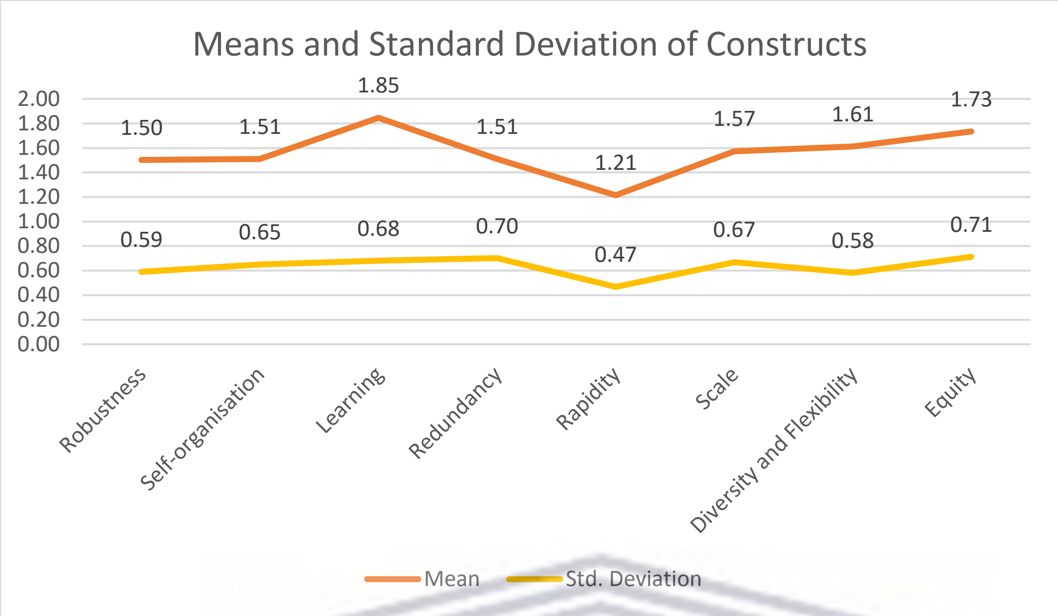


Figure 5-9: Mean and Standard Deviation of Attributes

To perform inferential statistics on the robust traits that underpinned the framework, the scoring was important. Descriptive statistics were used to get the findings shown in Figure 5-9 above.

As previously shown by the frequency results, most respondents were neutral on the Resilience attribute variables, as evidenced by the group averages and standard deviation values. Of all the adoption constructs for digital technologies in the AVC framework, the Rapidity construct had the lowest mean and standard deviation. The lowest mean indicates that respondents agreed on the constructs the least, while the lowest standard deviation indicates that respondents' replies differed the least.

The Learning attribute of the suggested framework, which had the highest mean of all the traits, was largely endorsed by respondents. These findings are consistent with literature suggesting that learning and training should receive more attention because they are crucial to digital technology adoption in AVCS by small-scale farmers (see section 2.2).

The Equity attribute had the biggest standard deviation among the categories, indicating the greatest variation in responses among respondents. In conclusion, the findings show that although small-scale farmers think digital technology adoption in AVCs might help them increase their resilience, they face several obstacles when implementing it. The t-test findings for determining if there is a statistically significant difference between demographic variables and the attribute scores of the means and standard deviations are shown in the next section.

5.5 T-Test results of demographic variables

The t-test helped determine whether there were any notable variations between the resilience attributes variables' means and the demographic variables having two categories, such as gender and cell phone ownership. It was crucial to determine whether there were any significant differences between males' and females' perceptions of the adoption of digital technology in small-scale farmers' AVCs. The test findings would also show whether demographic factors affected the variables related to resilience attributes.

Table 5-2: T-test for demographic variables

Independent Variable	Dependent Variable	F value	t	Significance Two-Sided p	Categories
Gender	RobWeat (Robustness)	35.800	2,774	.006**	Male or Female
Gender	Robreport Robustness)	11.410	**4,247**	<,001***	Male or Female
Gender	LEATRA Learning	0,247	**-2,105**	0,037*	Male or Female
Mob (Own a mobile)	LEATRA Learning	6,306	2,206	0,029*	Yes or No
Mob (Own a mobile)	RAPEMER Rapidity	6,353	-2,456	0,015*	Yes or No

Note: * p< 0.05, ** p<0.01, *** p<0.001., (n=210)

The T-test analysis results aided in choosing participants for the following qualitative phase. The results of the t-test revealed significant differences in perceptions between male and female respondents regarding how robust it is to acquire weather information (p=.006). The findings imply that there are significant gender-based disparities in the respondents' perceptions of the availability of weather information. The findings indicate that female respondents were more in agreement than male respondents on the access to weather information variable (Table 5-2).

For male and female respondents, the gender variable also revealed significant differences with the Robustness variable to report issues and emergencies to institutions/authorities (p0.001) and the Learning variable to get training over the internet (p=0.037) (Table 5-2). The findings imply that the respondents' perceptions of the robustness and learning variables of the suggested digital technology adoption in AVCs implementation framework are influenced by the respondents' gender. In comparison to male respondents, female respondents were more in agreement with the conceptions of robustness and learning.

Between respondents who owned a mobile device and those who did not, the "Own a mobile" variable revealed a significant difference (p=.029) with the Learning variable (Table 5-2). The findings imply that respondents' perceptions of the Learning component of the proposed digital technology adoption in the AVCs implementation framework were significantly influenced by their ownership of a mobile device. The findings also imply that participants who own a mobile device are more likely to concur on the learning variable.

For respondents who owned mobile devices and those who did not, the "Own a mobile" variable revealed a significant difference (p=.0,015) with the Rapidity construct of receiving emergency relief more quickly (Table 5-2). The findings imply that owning a mobile device significantly influenced respondents' perceptions of the Rapidity variable of the proposed digital technology adoption in the AVCs implementation framework. This refers to accessing emergency relief quicker. The findings also imply that individuals who own mobile devices are more likely to concur with the Rapidity variable of quicker access to emergency relief.

5.6 Analysis of Variance (ANOVA) of demographic variables

The planned adoption of digital technology in the AVCs implementation framework resiliency variables was evaluated using ANOVA to determine whether there were any statistically significant differences between demographic characteristics with more than two categories. To determine whether more than two groups differed significantly from one another, multiple post hoc analysis was utilised.

Table 5-3: ANOVA for demographic variable (Age-range)

Independent Variable	Dependent Variable/Component	F value	Significance	Categories
Age-range	LEACOMM /Learning	5,134	0.002*	15 to 25 years 26 to 35 years 36 to 45 years More than 46
	REDHEL /Redundancy	3,962	0,009*	
	RAPEMER /Rapidity RAPEAR /Rapidity RAPSUPP /Rapidity	3,979 5,372 5,640	0,009* 0,002* 0,001	
	SCAGRO /Scale SCAINST /Scale	2,678 7,532	0,049 0,000*	
	DIVLIFE /Diversity & Flexibility DIVVIEW /Diversity & Flexibility DIVINFO /Diversity & Flexibility	5,453 3,175 5,064	0,026 0,002 0,001*	
	EQUAGRI /Equity EQSTREN /Equity EQUPROJ /Equity	5,504 2,984 7,656	0,001 0,033 0,000*	

The ANOVA between demographic variables and constructs showed significant differences between Age-range and variables' Learning ($p = .002$), Redundancy ($p = 0,009$), Rapidity ($p < 0,009$), Scale ($p < 0,049$), Diversity plus Flexibility ($p < 0.026$) and Equity ($p < 0.033$) (Table 5-3).

The results suggest that Age-range influences respondent attitudes towards learning, redundancy, rapidity, scale, diversity plus flexibility and equity constructs of the proposed framework. The results suggest that Age-range has a more positive attitude towards resilience attributes than others.

The differences between Age-range are very important to follow up on the qualitative phase to understand why the Age-range differs in perceptions of these attributes. The other framework attributes did not differ significantly with the Age-range variable.

Table 5-4: ANOVA for demographic variable (Type of occupation)

Independent Variable	Dependent Variable / Component	F value	Significance	Categories
Type of occupation	Robeme /Robustness	3,368	0,020	Employed
	Robreport /Robustness	3,417	0,019	Retired
	SELFVC /Self-Organisation	3,713	0,013	Unemployed
	SELTRUST /Self-Organisation	4,753	0,003	Other
	LEATRA /Learning	8,459	<,001	
	REDINC /Redundancy	3,203	0,025	
	REDHEL /Redundancy	5,843	0,001	
	RAPEMER /Rapidity	4,452	0,005	
	RAPEAR /Rapidity	14,851	<,001	
	RAPSUPP /Rapidity	5,454	0,001	
	SCAGRO /Scale	5,085	0,002	
	SCAINST /Scale	10,300	<,001	
	DIVVIEW /Diversity & Flexibility	7,553	<,001	
	DIVINFO /Diversity & Flexibility	4,073	0,008	
	EQUAGRI /Equity	8,370	<,001	
	EQSTREN /Equity	5,229	0,002	
	EQUPROJ /Equity	14,078	<,001	

The analysis of variance was conducted between type of occupation and resilience attribute variables, where robustness ($p < .020$), self-organisation ($p < .013$), learning ($p < .001$), redundancy ($p < 0.25$), rapidity ($p < 0,050$), scale ($p < 0,002$), diversity plus flexibility ($p < 0.008$) and equity ($p < 0.002$) differed significantly with type of occupation (Table 5-4).

The results suggest that the type of occupation influences attitudes towards robustness, self-organisation, learning, redundancy, rapidity, scale, diversity plus flexibility and equity. The more a respondent's type of occupation is exposed to digital technology adoption, the more the respondent was likely to agree that small-scale farmers can enhance these resilience attributes through digital technology adoption in AVCs.

The analysis of variance for the demographic and resilience attribute variables was covered in this section. The findings demonstrated that four demographic variables differed significantly from several resilience attribute variables. So, it was crucial to carefully choose participants for the second phase of qualitative interviewing. Having discussed the ANOVA of the Resilient attributes variables, the next section presents the correlation results of the Resilient variables among each other.

5.7 Correlation Results of the Resilient Attributes Constructs

To ascertain whether there was a relationship between the variables, a correlation was performed. The results of the correlation between the resilience attribute variables are shown in this section. Correlation analysis statistics were used to assess the association between Resilient Attributes variables and the impact on the proposed digital technology adoption in the AVCs implementation framework. Correlation analysis helped to determine the degree or strength of the relationship between the variables and how it relates to the digital technology adoption in AVCs implementation framework from the participants' perceptions.

Table 5-5: Correlation Matrix Analyses

Correlations between the Resilience Attribute Variables

		1	2	3	4	5	6	7	8
1	Robustness	1							
2	Redundancy	.498**	1						
3	Rapidity	.525**	.631**	1					
4	Selforganisation	.514**	.622**	.491**	1				
5	Learning	.366**	.433**	.312**	.526**	1			
6	Scale	.459**	.575**	.535**	.578**	.457**	1		
7	DiversityFlexibility	.323**	.590**	.638**	.543**	.333**	.704**	1	
8	Equality	.455**	.610**	.400**	.685**	.622**	.616**	.475**	1
	**. Correlation is significant at the 0.01 level (2-tailed).								

According to the correlation analysis results shown in Table 5-5, there was a strong positive significant association among all the Resilient Attributes variables . The next sub-sections discuss the correlation results of individual Resilient Attributes variables in relationship with other variables.

5.7.1 Robustness Attribute Correlation Results

The Robustness attribute variable has a strong and significant correlation with the Redundancy variable (.498**), Rapidity variable (.525**), Self-Organisation variable

(.514**), Learning variable LEASHA (.366**), Scale variable (.459**), Diversity & Flexibility variable (.323**) and Equity variable (.455**).

The correlation results suggest that Redundancy, Rapidity, Self-Organisation, Learning, Scale, Diversity & Flexibility and Equity attribute variables have a positive relationship with the Robustness attribute and are therefore an important part of the proposed framework. The results suggest that the seven attributes have a positive relationship with Robustness, which suggests that a change in one attribute is followed by changes in the other attribute in the same direction. In short, the results suggest that if small-scale farmers improve all other attributes, they are likely to get positive attitudes towards Robustness from small-scale farmers. The seven attributes are therefore important parts of the framework as they have a connection with Robustness.

5.7.2 Redundancy Attribute Correlation Results

The Redundancy attribute variable has a strong and significant correlation with Rapidity variable (.631**), Self-Organisation variable (.622**), Learning variable (.433**), Scale variable (.575**), Diversity & Flexibility variable (.590**) and Equity variable (.610**).

The correlation results suggest that Rapidity, Self-Organisation, Learning, Scale, Diversity & Flexibility and Equity attribute variables have a positive relationship with the Redundancy attribute. The results suggest that the six attributes have a positive relationship with Redundancy, which suggests that a change in one of these attributes is followed by changes in the other attribute in the same direction. In short, the results suggest that if small-scale farmers improve all other attributes, they are likely to get positive attitudes towards Redundancy. The six attributes are therefore important parts of the framework as they have a connection with Redundancy.

5.7.3 Rapidity Attribute Correlation Results

The Rapidity attribute variable has a strong and significant correlation with the Self-Organisation variable (.491**), Learning variable (.312**), Scale variable (.535**), Diversity & Flexibility variable (.638**) and Equity variable (.400**).

The correlation results suggest that Self-Organisation, Learning, Scale, Diversity & Flexibility and Equity attribute variables have a positive connection with the Rapidity attribute and are therefore an important part of the proposed framework. The results suggest that the five attributes have a positive relationship with Rapidity, which suggests that a change in one attribute is followed by changes in the other attribute in the same direction. In short, the results suggest that if small-scale farmers improve these attributes, they are likely to get positive attitudes towards Rapidity. The five attributes are therefore important parts of the framework as they have a connection with Rapidity.

The results suggest that Rapidity correlates with all attributes of resilience and the proposed framework. The results suggest that Rapidity and the other attributes complement each other's weaknesses. The results suggest that there is an association between Rapidity and these attributes. The results support the literature that there is a relationship between these resilience attributes and suggest that these attributes are aligned with Rapidity.

5.7.4 Self-Organisation Attribute Correlation Results

The Self-Organisation attribute variable has a strong and significant correlation with Learning variable (.526**), Scale variables (.578**), Diversity & Flexibility variable (.543**) and Equity variable (.685**).

The correlation results suggest that Learning, Scale, Diversity & Flexibility and Equity attribute variables have a positive relationship on the Self-Organisation attribute and are therefore an important part of the proposed framework. The results suggest that the four attributes have a positive relationship with Self-Organisation, which suggests that a change in one attribute is followed by changes in the other attribute in the same direction. In short, the results suggest that if small-scale farmers improve all other attributes, they are likely to get positive attitudes towards Self-Organisation of small-scale farmers. The four attributes are therefore important parts of the framework as they have connection with Self-Organisation.

5.7.5 Learning Attribute Correlation Results

The Learning attribute variable has a strong and significant correlation with Scale variable (.457**), Diversity & Flexibility variable (.333**) and Equity variable (.622**).

The correlation results suggest that Scale, Diversity & Flexibility and Equity attribute variables have a positive connection with on the Learning attribute and are therefore an important part of the proposed framework. The results suggest that the three attributes have a positive relationship with Learning, which suggests that a change in one attribute is followed by changes in the other attribute in the same direction. In short, the results suggest that if small-scale farmers improve all other attributes, they are likely to get positive attitudes towards Learning of small-scale farmers. The three attributes are therefore important parts of the framework as they have a relationship with Learning.

5.7.6 Scale Attribute Correlation Results

The Scale attribute variable SCAGRO has a strong and significant correlation with Diversity & Flexibility variable (.704**) and Equity variable (.616**).

The correlation results suggest that Diversity & Flexibility and Equity attribute variables have a positive relationship on the Scale attribute and are therefore an important part of the proposed framework. The results suggest that the two attributes have a positive relationship with Scale, which suggests that a change in one attribute is followed by changes in the other attribute in the same direction. In short, the results suggest that if small-scale farmers improve all other attributes, they are likely to get positive attitudes towards Scale attribute of small-scale farmers. The three attributes are therefore important parts of the framework as they have a relationship with the Scale.

5.7.7 Diversity & Flexibility Attributes Correlation Results

The Diversity & Flexibility attribute variable DIVLIFE has a strong and significant correlation with Equity variable EQSTREN (.475**).

The correlation results suggest that Equity attribute variables have positive connection to the Diversity & Flexibility attribute and are therefore an important part of the proposed framework. The results suggest that the attribute has a positive relationship with Diversity & Flexibility, which suggests that a change in one attribute is followed by changes in the other attribute in the same direction. In short, the results suggest that if small-scale farmers improve all other attributes, they are likely to get positive attitudes towards Diversity & Flexibility. The attributes are therefore important parts of the framework as they have a relationship with Diversity & Flexibility.

5.7.8 Equity Attribute Correlation Results

The correlation results above suggest that Robustness, Redundancy, Rapidity, Self-Organisation, Learning, Scale and Diversity & Flexibility attribute variables have a positive relationship with the Equity attribute and are therefore an important part of the proposed framework. The results suggest that the seven attributes have a positive relationship with Equity attribute, which suggests that a change in one attribute is followed by changes in the other attribute in the same direction. In short, the results suggest that if small-scale farmers improve all other attributes, they are likely to get positive attitudes towards Equity attribute from small-scale farmers. The seven attributes are therefore important parts of the framework as they a connection with the Equity variable.

5.8 Regressions Analysis on Access to Internet

The stepwise regression analysis was used to assess which demographic variables had an influence on the Access to Internet variable. It first input other demographic variables as independent variables against the Access to Internet as the dependent variable.

Table 5-6: Regression Analysis

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	1.036	.244		4.240	<,001
	Age range	.230	.041	.444	5.577	<,001
	Type of Occupation	.080	.046	.128	1.735	.085
	Gender	-.249	.080	-.245	-3.110	.002

a. Dependent Variable: Access to Internet

Sample (n=210)

When Access to Internet is the dependent variable, the stepwise regression results suggest that only Age range and Type of Occupation have a significant positive predictive effect on Access to Internet, with Gender having a slightly negative impact (see Table 5-6). The overall model explained 44% of the variance in Age range, which was revealed to be statistically significant, t (5, 57) = .444, $p < .001$. An inspection of individual predictors revealed that Age range and Type of Occupation variables are significant predictors of Access to Internet variable. The other variables had no impact on Access to Internet variable. Significant variables are shown in Table 5-6.

According to the results in Table 5-6, the Age range and Type of Occupation variable would predict positive impacts on participants' perception of Access to Internet. On another note, the results show that Gender has a slight negative impact on Access to Internet variable. The results suggest that Age range and Type of Occupation are stronger predictors of Access to Internet. The findings of this study support Bayer (2018) and Begashaw et al. (2019) in their belief that young people should be involved in developing and implementing sustainable digital technology adoption in AVCs of small-scale farms (see section 2.8).

The findings of the regression analysis show that the three framework factors (Age range, Type of Profession and Gender) statistically affect Small-Scale Farmers' Access to Internet. Age became an important determinant of internet access. Gender has also been shown to have a substantial impact on internet access. The Type of Employment was found to be a marginally less important predictor of Internet Access.

The findings imply that other demographic dimensions are not reliable predictors of the Access to Internet variable. While not being significant predictors of the Access to Internet variable, the other constructs exhibited a substantial positive connection with those that were (Age range, Type of Occupation and Gender). The findings thus imply that each component is a crucial part of the suggested framework. The findings emphasize the significance of age range for digital technologies adoption in AVCs of small-scale farmers.

5.9 Discussion

The results suggest that, on average, respondents supported the proposed digital technology adoption in AVCs of small-scale farmers' framework components. This is because all the resilient attributes scored above average means from a score of 1.21, the lowest, to 1.85, the highest. The frequency results show that most respondents agreed on most variables of the resilience attribute variables. Diversity and Flexibility attribute frequencies had the highest score, which supports the literature that digital technology adoption in AVCs of small-scale farmers creates more opportunities. However further correlation analysis revealed that Diversity and Flexibility had an association with other Resilience attributes, suggesting that it is an important component of the proposed digital technology adoption in the AVCs framework as shown in Table 5-5.

The t-test results suggest that there are significant differences between the ‘gender’ variable and ‘Robustnes (access to weather information report problems and emergencies), as well as between ‘Own a mobile’ and ‘Rapidity’, ‘Learning’. The analysis of variance (ANOVA) results also indicated significant differences between Age range and the variables’ learning, redundancy, rapidity, scale, diversity plus flexibility and equity. The type of occupation variable showed significant differences between robustness, self-organisation, learning, redundancy, rapidity scale, diversity plus flexibility and equity. The results support the literature that stakeholders have different worldviews about digital technology adoption in AVCs of small-scale farmers.

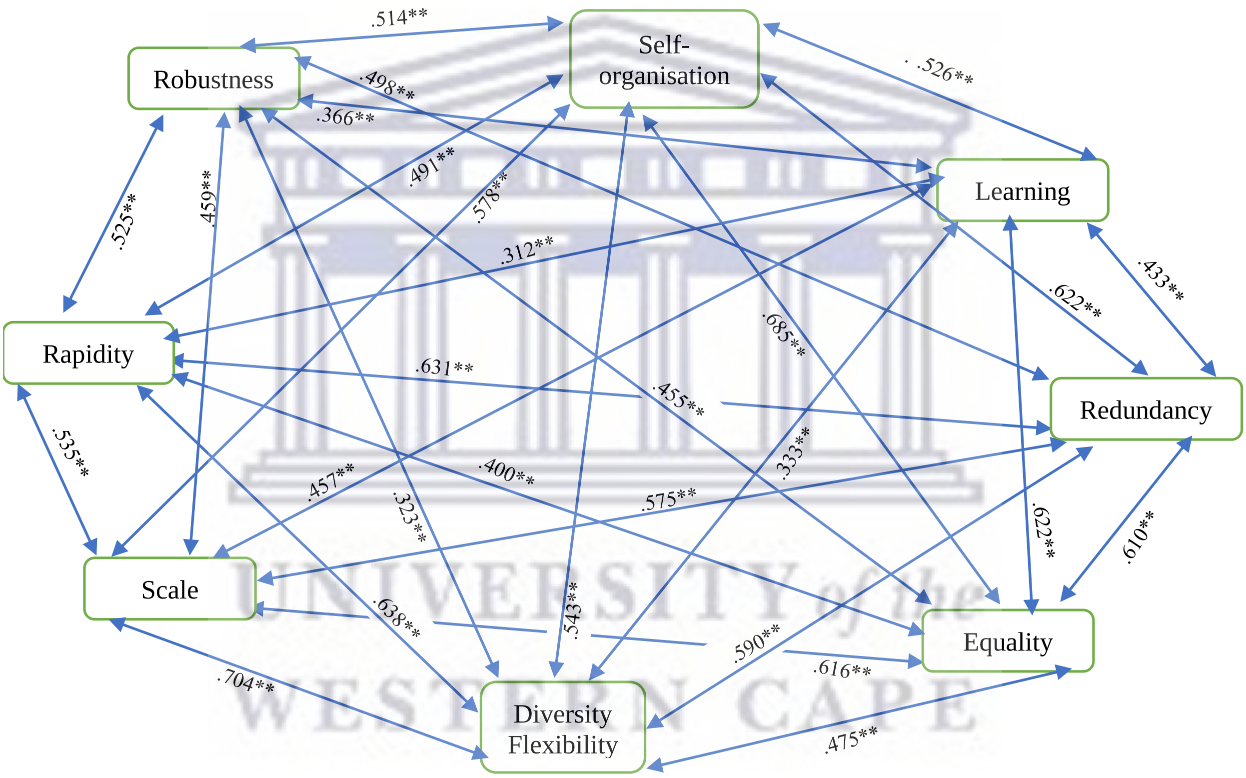


Figure 5-10: Correlation Results Summary (P> 0.001).**

The correlation results suggest that Redundancy, Rapidity, Self-Organisation, Learning, Scale, Diversity & Flexibility and Equity attributes variables have an influence on the Robustness variable and are therefore an important part of the proposed framework. The results suggest that there is an association between Redundancy and these variables. The results support the literature that there is a relationship between these resilience attributes and suggest that these attributes are aligned with Redundancy.

The results suggest that Robustness variable perception can be improved when there is an improvement in the Redundancy, Rapidity, Self-Organisation, Learning, Scale, Diversity & Flexibility and Equity variable variables. To improve Robustness perception of small-scale farmers, it may therefore be necessary to improve Redundancy, Rapidity, Self-Organisation, Learning, Scale, Diversity & Flexibility and Equity variable variables in AVCs of small-scale farmers. This was also supported by the regression analysis which indicated that the results from the regression analysis indicate that the three variables of the framework (Age range and Type of Occupation) statistically influence the Access to Internet for small-scale farmers. The results support the literature in that the components of the framework may complement each other.

Although other variables did not have a predictive power and strong significant correlation on Access to Internet, they had an association with predictors (Age range and Type of Occupation) of the Personal characteristics. The results indicated that other variables, except Gender, have an association with predictors (Age range and Type of Occupation), which is important in that they have an influence on the predictors of Access to Internet. Regarding the relationship between variables, Gender showed that it did not have a relationship with other variables of the framework. In other words, Gender does not contribute to the proposed digital technology adoption in the AVCs framework and is therefore not an important component.

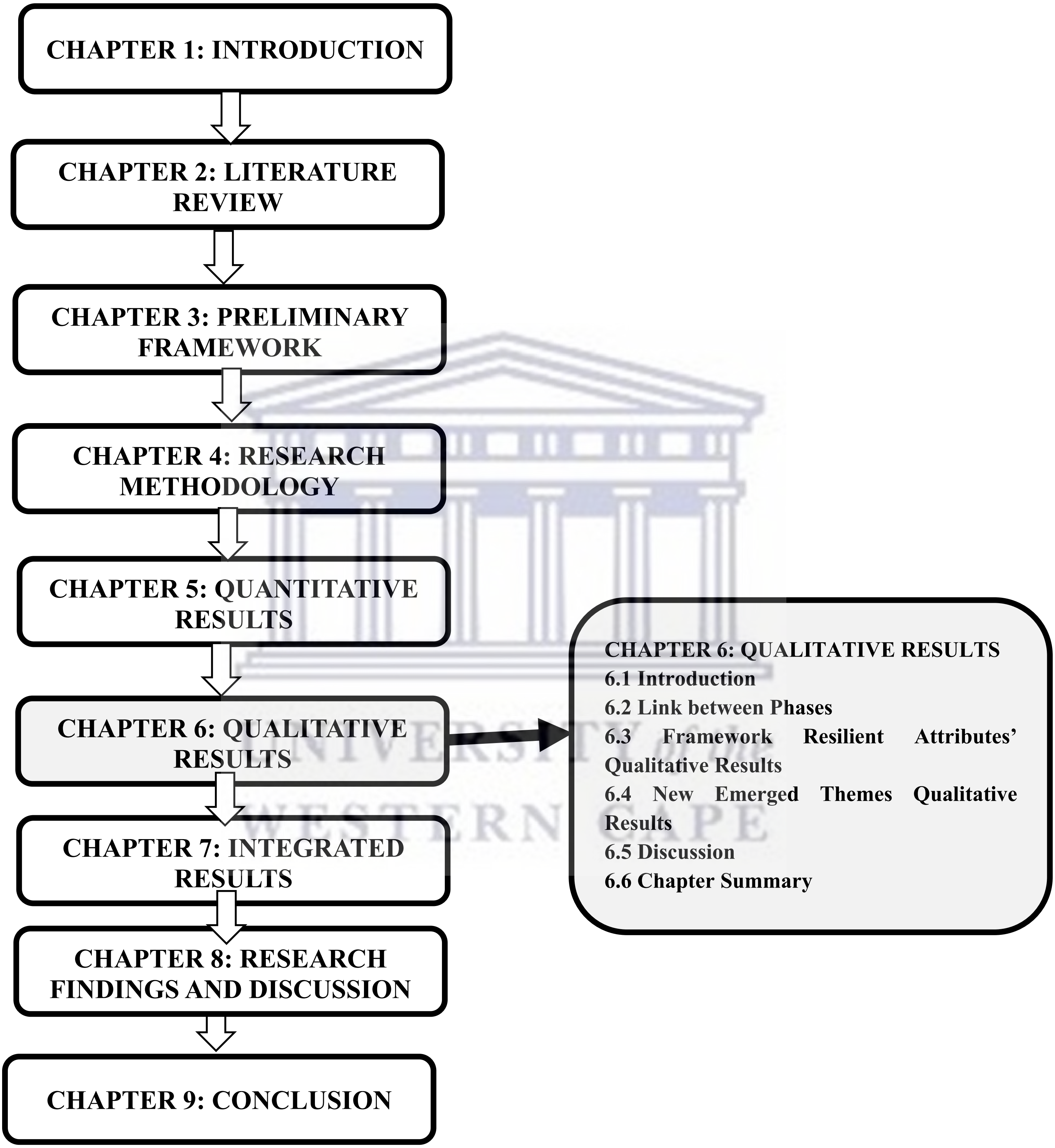
5.10 Chapter Summary

The quantitative results indicate that the framework components effectively address digital technology adoption concerns in AVCs of small-scale farmers. The framework can influence adoption based on predictive constructs, but gender did not contribute significantly to the adoption of digital technology in AVCs, as it did not correlate with other constructs.

The study used an explanatory sequential design to explore unexpected quantitative findings. The quantitative sample was questioned during the qualitative phase to gain an inside perspective on the associations between variables. A qualitative case study was conducted to understand participants' experiences and understanding of the variables in their everyday life. The quantitative findings guided the study's sampling procedure, research questions, and data collection in the qualitative phase. The aim was to gain a deeper understanding of the phenomena studied.

This section discusses the quantitative results from questionnaires used in the initial research, while the qualitative interview phase provides context and understanding of hard-to-quantify behaviors. The next chapter will explore the results of the qualitative interview phase.

CHAPTER 6: DIAGRAMMATIC OVERVIEW



6 Chapter 6: Qualitative Results

6.1 Introduction

The quantitative research findings from the small-scale farmers' questionnaire data were reported in the previous chapter. A variety of statistical findings from quantitative analysis were covered in the results from the previous chapter. The qualitative findings from participant data obtained through semi-structured interviews are presented in this chapter. The quantitative phase was followed by the qualitative interview stage. The objective of the qualitative phase was to follow up in order to compare and explain the quantitative data in more depth. To strengthen the validity of some of the quantitative findings, the qualitative results were helpful. The chapter concludes with a summary. Certain questions that the quantitative results were unable to address were also successfully addressed by the qualitative interview results.

6.2 Link between Phases

The second phase's interview protocol was created using quantitative data, which were also utilised to carefully choose the participants for the qualitative phase. Using a stratified purposive sampling technique, participants for the qualitative phase were chosen from the quantitative phase sample to address the study topic. Purposeful sampling assisted in choosing a small number of participants who may offer insightful data pertinent to the research topic.

Table 6-1: Interviewee profiles (n=13)

Interviewee position	Number of interviewees	Organisation
Farmers	3	I Female, 1 male and 1 youth
Agri-food Technologist	1	Cape Peninsula University of Technology
Agriculture Extension Management	1	One District
Commodity Organisation	1	SA Potato Board Member
International Development NGO and National Development NGO	2	UN/FAO Representative, Distell Trust Board Member
Agriculture Co-operative Leaders	3	1 Urban, 1 Rural and 1 Woman
Community Development Practitioners	2	1 male and 1 female

Thirteen participants, who were carefully chosen from the small-scale farmer stakeholders, made up the sample size. The profiles of those that were interviewed are shown in Table 6-1.

Each interview was conducted individually, was semi-structured, lasted between 35 and 60 minutes, and was tape recorded with each participant's permission. The qualitative interview phase was important as a follow up to investigate the inconclusive quantitative results.

6.3 Framework Resilient Attributes' Qualitative Results

The qualitative findings from the interviews about the resilience attributes that are impacted by digital technology adoption in the AVCs framework are presented in the next section. The participants were interviewed to learn more about how they saw the resilience qualities affecting the digital technology adoption in the AVCs framework. The interviews aim to determine how the three fundamental foundations of resilience (robustness, self-organisation, and learning) and the six secondary enablers of resilience (redundancy, rapidity, scale, diversity, flexibility, equality) are affected by digital technology adoption in the AVCs of small-scale farmers.

Digital technologies can play an important role in impacting rural resilience for agricultural livelihoods against external stressors. This will assist us to establish the role of digital technologies adoption in AVCs to develop the resilience of small-scale farmers. The stronger these are, the more resilient farmers will become through the implementation of digital AVCs (see section 2.6). The next section presents the results from the interviewed participants.

6.3.1 Robustness Qualitative Results

The qualitative phase provided evidence that small-scale farmers have very strong personalities, which is significant because it is one of the three main pillars of resilience. Participants in the interviews emphasised their experience in farming. Most participants in the qualitative phase cited their motivation, knowledge and being well-informed as arguments in favour of the Robust attribute. Moreover, they should be able to improvise when a project is profitable. The majority of participants made the point that they support sustainable livelihoods and are compelled to survive. The participants noted that they can handle crises and know how to cultivate since they have over the years acquired indigenous wisdom. Some participants made the point that they start from scratch to develop something.

Small-scale farmers could use digital technology in AVCs to improve their resilience, according to the qualitative phase. The participants in the interviews emphasised that they obtain information from a variety of unidentified sources and that digital technologies can play a significant role in information research. They stated that adopting digital tools for communication and information gathering could strengthen them.

The majority of those interviewed emphasised how using digital technologies in small-scale farmers' AVCs can increase their robustness and resilience. The majority of participants anticipated that using digital technology will improve, streamline, increase profitability and sustain their farming operations. The participants went on to say that they anticipated digital technology adoption in AVCs would be able to provide more extended support in terms of access to land, financial options, inputs and markets.

The following comments from the participants who were interviewed provide support to the ideas presented above about how digital technology adoption in AVCs can improve small-scale farmers' robustness, which affects their resilience.

> *"Our positive characteristics include that we know how to farm. I want to make money and thus work hard. I am prepared to react to any crises to survive." "Our main source of information comes from the internet and cell phones. The rate of usage or adoption of mobile phones by small-scale farmers is growing."* **Participant 1 (Young Female Farmer)**

> *"We are visionary and create our own produce from nothing and then sell it. We are robust; as we do not give up when dealing with hardships, we learn from them and move on. We know how to farm and start on a small piece of land with the ability to expand as the opportunity arises." "Digital technology plays a big role and makes it very easy to communicate amongst each other. When crops are attacked by insects, advice can be given over the phone using pictures and you do not need to go there. ICT plays a big role where they can research funding Instruments available. These days nothing can be done without the use of technology."* **Participant 2 (Urban Co-operative Leader)**

> *"They use their human asset to empower themselves and are prepared to sacrifice to survive. They are innovative and have values as some of them are even prepared to work without getting paid but only receiving some of the produce."* **Participant 3 (Trust Board Member)**

> *"Our positive characteristics include that we possess a lot of knowledge of how to farm. Most of us have worked on farms for years and thus have acquired the knowledge." "ICT plays a big role and is definitely the way forward. The internet is loaded with additional knowledge and training. They have mobile phones, and in order to improve, they do not need to look for experts as everything they need is shared on the Internet."* **Participant 4 (Male Farmer)**

"Their positive characteristics are that they are very determined to succeed. They do whatever they need to do to survive. Although the infrastructure and knowledge used is very primitive, the desire to succeed drives them. They never meet the critical wall where they would give up, but always find ways to make it work and survive." **Participant 5 (Agri-food Technologist)**

"Positive characteristics include that they contribute to food security and job creation. They do not have much of a choice but to respond to disasters as it affects their livelihoods. Whether they are ready is another question." "They lack access to land, finance capital and credit in terms of legislation. They also lack knowledge of how to access the markets. They need information about land available, credit and what is happening within the commodity organisations. They collaborate along commodity groupings and use WhatsApp to communicate. There is a major increase in the usage or adoption of mobile phones by small-scale farmers to communicate. They also sometimes need to apply online to access certain opportunities." **Participant 6 (Manager Extension Support)**

"We are prepared to face economic and climate challenges." "ICT plays a big role and cell phones are used to communicate fast." **Participant 7 (Women Co-operative leader)**

"We are very robust and prepared to respond to disasters or climatic and economic emergencies. We work in harmony with nature." "We do not have access to markets and funding. There is a lot of us using WhatsApp. ICT plays a big role and can expose you to more research opportunities. Training and support need to be provided." **Participant 8 (Potato Board)**

"Small-scale positive characteristics include that they know how to farm." "I have no knowledge of how information is gathered. Digital technologies play a big role, and the use is rising." **Participant 9 (Community Development Practitioner 1)**

"We know how to farm. We always make sure that we are informed about any looming crises such as rainstorms. We know about the weather patterns in their area. Crises were not that bad yet. The only things are the rain and dew in the morning for which we are well prepared". "Internet and cell phones, together with the willing neighbouring farmers, are our main sources of info." **Participant 10 (Rural Co-operative leader)**

"We know how to farm and will fight for what we need to survive any crises. We are prepared to respond to disasters or climatic and economic emergencies." "An

economic challenge is that although we farm to sell all the produce, they sometimes do not sell everything, and some might go wasted. There is a rise in the adoption of mobile phones and internet usage by us. We can find lots of information that assists us to deal with our challenges." **Participant 11 (Female farmer)**

"Positive characteristics include that they know how to farm". "Cell networks need to be upgraded, as they provide apps on how to deal with climate change." **Participant 12 (UN-FAO Representative)**

"They are still positive and believe the project is lucrative, and this is an opportunity to build a piggery livestock business. They have taken wires and planks to try and secure some of the animals." "They use cell phones to communicate with each other and some use the internet to search for and share information. Digital technologies play a big role amongst the youth and those who can afford them. Those with cell phones use the internet. Some of the older farmers have outdated cell phones that cannot access the internet." **Participant 13 (Community Development Practitioner 2)**

The qualitative findings were consistent with findings from other research obtained from the literature. For instance, the qualitative results lend support to the research on the perceived link between the livelihoods of small-scale farmers and the reduction of poverty. Additionally, utilising digital technology in AVCs can help enhance rural livelihoods and farmer capacities (Mago & Mago, 2015). This explains why it is essential to understand the development needs of small-scale farmers and how to get involved locally as agricultural innovations, including digital technology, are implemented (Agri-Symposium, 2019).

Digital technologies enable new options to deliver extension services that are tailored to local conditions, opening up new opportunities to increase the robustness of farmers as agriculture becomes more knowledge intensive (Deichmann et al., 2016; NAHF, 2017). The perceived value of technology in strengthening the resilience of small-scale farmers is a matter of opinion because it is typically associated with swift and occasionally disruptive changes in society and organisations. Different people have various opinions about how valuable technology is, depending on how institutions use it (see section 2.5.3).

In addition, the aforementioned research identified several external barriers to small-scale usage of digital technology adoption in AVCs of small-scale farmers. Given their high cost, digital technologies may not be used to their full potential in terms of productivity and economic sustainability. This suggests that for digital technology to be successfully used in small-scale agriculture, the government and other agricultural sector development organisations must help (see section 2.2.6).

6.3.2 Self-Organisation Qualitative Results

The majority of the participants who were interviewed believed that there is fierce competition for the few resources available, which prevents them from speaking with a unified voice. Other participants also stated that due to politics and the desire for financial gain, there are times when people do not trust one another. The qualitative phase shows that small-scale farmers can improve their self-organisation attributes to become more resilient through teamwork by integrating digital technologies into their AVCs.

Participants noted that, in some cases, they have good relationships and built trust due to them sharing the same history. The participants highlighted the importance of exchanging produce with each other. Most of the interviewed participants felt that they can act as a team and implement good practices to sell collectively. The qualitative phase identified the lack of self-organisation support for small-scale farmers, against the effects of climate change and economic challenges. They need institutional support to self-organise to establish trust and commitment to opportunities.

The following quotes from the interviewed participants support the above views on how the adoption of digital technology in AVCs can assist in self-organisation that impacts the resilience of small-scale farmers.

> "*We have a high ability to self-organise us. There is some trust among us, and there is a level of mistrust amongst us. There are social networks or networks of collaboration that exist. We get the support of neighbours in time of crises.*"' **Participant 1 (Young Female Farmer)**.
>
> *"We are good at organising ourselves. No one is moving alone. We move as a team with a board to lead. We also have a bank account with a business plan. We share good practices, and we create scale by working together and selling to the market."* **Participant 2 (Urban Co-operative Leader)**
>
> *"Sometimes they form co-operatives to supply bulk to the market. They form specialist social networks with overseas enterprises but are hampered by the need for certain food safety requirements. Deficiency of trust, as the low resources available causes*

them to compete against one another as they vie for the same money." **Participant 3 (Trust Board Member)**

"There is good relationship amongst us as everyone is struggling to get off the ground. Commercial farmers will give advice but cannot provide resources as they are going through the same challenges. Most of our support we get from a few of the commercial farmers. If all of us can get together and speak with one voice, these challenges can be addressed. Will take more than a day to discuss all the challenges." "Not enough has been done to assist us to self-organise. There are no policies to assist, and you must plan yourself." **Participant 4 (Male Farmer)**

"They are not organised, thus they make quick decisions for their benefit. Not enough has been done to assist them to self-organise." **Participant 5 (Agri-food Technologist)**

"They are very good at organising themselves in times of crises. When accessing resources, it often leads to conflict as resources are not enough for everyone." **Participant 6 (Manager Extension Support)**

"As a member of the Fire network task team, we co-ordinate that everyone is informed and help each other. We do self-organise although there is a low level of trust amongst us as small-scale farmers. Thus, the network among us is not that strong.' **Participant 7 (Women Co-operative leader)**

"When they meet as PLAS farmers, they highlight all their issues but do not see each other again after that. They need to form a united front. Traditional knowledge/indigenous practices are still being used but not shared." **Participant 8 (Potato Board)**

"They can organise themselves when there are crises. They do not trust each other, but most of the time, they are forced to work together. Too much politics involved, and they form groups." "There is not enough done to assist them to self-organise." **Participant 9 (Community Development Practitioner 1)**

"We know each other's history, have walked a long way together and this has created a deep sense of trust amongst us. We assist each other and take hands when it comes to crises. Only when some farmers wanted to break away from the group and wanted to do their own thing caused some mistrust but ultimately, the trust was restored. Some of us are not paper qualified, and this creates conflict with those who are. Farmers are organised in a co-operative and work together as a group. Some individuals want to

break away, and this causes friction that can lead to legal challenges". **Participant 10 (Rural Co-operative leader)**

"We organise among ourselves, in case of crisis or problems. There are times when people like our neighbouring farmers with resources are prepared to assist". **Participant 11 (Female farmer)**

"They produce for themselves and then sell or exchange with their neighbours before selling in their immediate vicinity. Too much politics involved. Not enough has been done to assist them to self-organise." **Participant 12 (UN-FAO Representative)**.

"In times of crises, they are committed to working together. They are registered as an organisation. There is trust and commitment, and they use WhatsApp to communicate with one another. Due to the lack of resources, they find it hard to work together". **Participant 13 (Community Development Practitioner 2)**

The aforementioned remarks imply that there was broad agreement among the interviewees on the significance of small-scale farmers' self-organisation for the successful adoption of digital technology in AVCs. To ensure that digital AVC solutions are widely used and financially successful, it is crucial to understand what farmers value (Wisdom et al., 2018). The qualitative findings point to the necessity for enhanced stakeholder communication in self-organisation. Because smallholder farmers are frequently dispersed, digital technologies are essential for connecting them to better self-organise (see section 2.2).

The results are in line with the two strategic approaches, community involvement and collaboration, that are required to satisfy small-scale farmers' digital technology information demands (Awuor et al., 2016). Even though collaboration is essential to bringing about collective activities, nonetheless, it is important to be vigilant regarding dynamic capabilities among players (FAO et al., 2020). The qualitative findings demonstrated that there is occasionally a lack of faith in self-organisation due to competition for scarce resources.

As part of the community engagement strategy, the findings also support the idea that farmers should be included in the planning and implementation of digital technology solutions. When local farmers support them and are more actively involved in the planning and implementation of innovative programmes, they have a higher probability of success (Habiyaremye et al., 2019). Bayer (2018) found that small-scale farmers are most likely to accept digital solutions if they believe those solutions to be reliable and pertinent. Small-scale farmers must therefore collaborate and participate in the development of policies that will promote the adoption of such technology. Prior study has shown that small-scale farmers' participation and self-organisation are essential in the formulation of policy for digital technology adoption in AVCs (See section 2.8.).

6.3.3 Learning Qualitative Results

Interviewees agreed that learning is necessary before implementing digital technology in small-scale farmers' AVCs, which is aligned with the quantitative findings. The majority of those surveyed emphasised that small-scale farmers continue to use traditional farming techniques while learning from the past and imparting their knowledge.

The participants further stated that they anticipated learning more when they incorporated modern digital technology into their AVCs while employing traditional knowledge and indigenous practices. The majority of the participants who were interviewed mentioned that they strive to modernise farming practices and are keen to learn. According to some participants in the interviews, the government does not take note of what has proven successful in other provinces.

The qualitative phase was in favour of providing small-scale farmers with training in the use of digital technology to improve their resilience attributes. Participants in the interviews emphasised the necessity for ongoing digital support and financing options. The majority of the participants who were interviewed stated that they required ongoing education, assistance and training while integrating digital technologies into their AVCs by using some form of digital hubs. Participants in the interviews also mentioned the value of regularly consulting online training manuals and online extension support.

The following quotes from the interviewed participants support the above views on the learning that impacts the resilience of small-scale farmers.

> "*We do learn from experience and do share our experiences and knowledge. Some do use traditional knowledge plus indigenous practices and others don't.*" **Participant 1 (Young Female Farmer)**
>
> *"They learn from each other." "Although mobiles had improved, some members of the older generation have a problem using them and need training." "Digital technologies can be used to measure the moisture of soil, but training with support needs to be provided in the form of Digital Hubs."* **Participant 3 (Trust Board Member)**

"Mobile phones play a big role, but a lot of us do not know how to use them. It will be good to get the necessary training and applications. Constant support needs to be provided." **Participant 4 (Male Farmer)**

"Small-scale farmers do lack knowledge as most use traditional methods that won't be enough going forward. They are willing and eager to learn and get training to take farming operations to the next level. They do not share their knowledge. Agro-Technology station is trying to create a network for them to share knowledge." **Participant 5 (Agri-food Technologist)**

"Traditional knowledge plus indigenous practices are still being used, especially as substitutes for fertilisers and chemicals when it comes to crops. They learn from disaster experiences. Whether they can use the knowledge gained is dependent on the resources available. It is common for small-scale farmers to share their experiences and their knowledge with each other." "Not enough training in terms of the use of digital technology is also a major disadvantage. The majority of farmers are old and are not eager to accept this new technology. Digital technology has assisted communication to improve for the better. There remains a lack of training and support that plays a big role as a lot of them do not know how to use it. Training needs to be provided. Lack of skills in managing a business. Some training is online, and they need the skill of using digital technology." **Participant 6 (Manager Extension Support)**

"Traditional knowledge and indigenous practices are still being taken inconsideration.' **Participant 7 (Women Co-operative leader)**

"They do not have the skills in using new digital technology." **Participant 8 (Potato Board)**

"They learn from experiences. Most of the time, they do share experiences and knowledge with each other. Traditional knowledge/indigenous practices are still being used." "Some are too old to learn and are not well educated. Training needs to be provided." **Participant 9 (Community Development Practitioner 1)**

"We learn from experiences and share our knowledge amongst each other. Traditional knowledge and indigenous practices are still being used, and we also share some of this knowledge with government departments." "We need to be trained on how to use new technologies. Some of us are not used to using digital technology. We are open and willing to use it if training and support is provided. Training needs to be provided, and cell networks need to be upgraded, as they provide apps on how to deal with Climate change." **Participant 10 (Rural Co-operative leader)**

"We learn from experiences and sometimes share our experiences and skill with other farmers." "More training and support need to be provided in the use of digital technology." **Participant 11 (Female farmer)**

"Northern Cape Province Government implemented a good system as they are used to water scarcity, and this can be expanded to other provinces." "Small-scale farmers have problems with finance and using new technology. Not enough support. ICT plays a big role, but many of them do not know how to use it. Training needs to be provided." **Participant 12 (UN-FAO Representative)**

"Yes, they do learn from experiences. Traditional knowledge plus indigenous practices are considered. Youth are very much interested and willing to learn from their seniors." "Although a lot of them do use digital technologies, they still need training and support to further improve on the use of these implements." **Participant 13 (Community Development Practitioner 2)**

The findings from the literature research on the necessity for learning while implementing digital technology in AVCs of Small-scale Farmers are consistent with the qualitative results. The findings from the qualitative interviews confirm previous research that small-scale farmers confront considerable barriers to implementing digital technology. This includes a lack of knowledge and training, inadequate infrastructure and high expenses (Bayer, 2018). One of the main goals of institutionalisation is to prepare academic institutions to internalise training and curriculum creation, as well as to train the many significant stakeholders (Anandajayasekeram, 2011).

Small-scale farmers required ongoing education, training and support while integrating digital technologies into their AVCs, which was supported by the qualitative phase. Thus, among the Sustainable Livelihoods framework's goals for sustainable rural livelihoods, according to Carney (2002), are expanding training access and fostering equal access to competitive markets.

To provide digital skills training that develops collaborative laboratories for knowledge development, training and coordination, the government built an iNeSI distributive model in each of the nine provinces (Ungerer et al., 2018). iNeSI collaborates with the provincial Colab as a driving force and thought leader to advance digital skills interventions and knowledge development (iNeSI, 2018).

The comprehensive framework that has been put forth tackles the "how" of training for digital technologies adoption in AVCs of small-scale farmers. To facilitate the training of digital skills, the framework recommends the creation of Provincial Agricultural Digital Innovation Hubs (PADIHs), which will work with iNeSI. The Agro-Food Hub creates opportunities for possible synergies among agricultural enterprises at local district level through services like training (see section 3.7).

6.3.4 Redundancy Qualitative Results

The qualitative findings about the redundancy attribute confirmed the quantitative findings in that most small-scale farmers require a secondary source of income to be sustainable. The participants also mentioned that they rely on their families and fellow participants for support. The majority of those surveyed concurred that while some small-scale farmers do save, it is generally impossible for most of them to do so. They must collaborate as they are dependent on different sources of money.

The following remarks from the participants who were interviewed provide credence to the thoughts expressed above regarding how redundancy affects small-scale farmers' resilience.

> "*Some of us have alternative sources of income, while others do not have.*" **Participant 1 (Young Female Farmer)**
>
> *"Some of the issues about our income are personal. Older people mostly have a Pension grant as an alternative source of income. However, they are proud to be able to generate some alternative income."* **Participant 2 (Urban Co-operative Leader)**
>
> *"Small-scale farmers depend on more than one income source. They cannot save, thus it is important to invest in human capital."* **Participant 3 (Trust Board Member)**
>
> *"We depend on each other and are dependent on more than one source of income. We are flexible, as it is hard, but we are forced to adapt to survive. Some must perform alternative labour to get extra income."* **Participant 4 (Male Farmer)**
>
> *"Funding support is becoming less each year. Difficult to sustain themselves. Need to have another source of income to survive."* **Participant 5 (Agri-food Technologist)**
>
> *"'The bigger they become, the more independent they are. While still emerging, they do depend on additional income such as family or alternative employment. It is not a custom for small-scale farmers to save money."* **Participant 6 (Manager Extension Support)**
>
> *"We need more than one source of income to survive.'* **Participant 7 (Women Co-operative leader)**

"We depend on our family. We do not usually save to re-invest. We would rather use the money." **Participant 8 (Potato Board)**

"Most of them do not have any other sources of income. Some are employed, and some have no other sources of income. Small-scale farmers depend on each other and access support from family and neighbours in times of crises. Some do save, while it is impossible for others." **Participant 9 (Community Development Practitioner 1)**

"'Income is a challenge as some inputs by us only make us get in any income from that in a few months. Some receive government grants, while others must perform alternative labour to get extra income." **Participant 10 (Rural Co-operative leader)**

"We depend on alternative sources of income. We can we save money but most of the time, it is impossible." **Participant 11 (Female farmer)**

"Normally dependent on a grant." **Participant 12 (UN-FAO Representative)**

"Small-scale farmers depend on each other as some of them do not have an income. Some do have an alternative income source. Some can save for the feed of the livestock, which is very expensive." **Participant 13 (Community Development Practitioner 2)**

The quantitative and qualitative findings support the need for alternative livelihoods found in the literature study. The capability set is a representation of the various lives that people can lead by making use of their resources and tools to achieve various objectives. To pursue other functionings, the individual has a right to alternative means and flexibility in capability choices (Sen, 1989).

The quantitative and qualitative findings are consistent with the research, which suggests that the adoption of digital technologies in AVCs of small-scale farmers can lead to the emergence of new sources of income. According to research, digital technology improves small-scale farmers' capabilities and livelihoods, which fosters economic growth and reduces poverty (Mago & Mago, 2015). Small-scale farmers frequently have access to social resources that enhance their capacity for collaboration, foster trust, and help them pursue their objectives of preserving their livelihoods. By implementing digital technology, they can improve social capital, which has a direct impact on other types of capital, as well as increase the effectiveness of small-scale farmers' incomes and saving rates (see section 2.4).

6.3.5 Rapidity Qualitative Results

The qualitative findings confirmed the quantitative findings by showing that integrating digital technologies into small-scale farmers' AVCs promoted the rapidity attributes that bolstered their resilience. They demonstrated that despite receiving almost little assistance from the government, the majority of small-scale farmers react rapidly to disasters. Several respondents, however, felt that small-scale farmers needed to respond to economic and climate change concerns more quickly.

The following remarks from the participants who were interviewed provide support to the opinions expressed above regarding the attribute of speed that affects small-scale farmers' resilience.

"*We do not react fast in times of crises. Accessing support takes long. There exists some early warning systems to warn of any crises.*" **Participant 1 (Young Female Farmer)**

"There is no support to assist us to react quickly in times of crises." **Participant 2 (Urban Co-operative Leader)**

"Rapidity can be improved." **Participant 3 (Trust Board Member)**

"We are quick to respond to disasters." **Participant 4 (Male Farmer)**

"They can change quickly because of size. Respond fast with the help of some neighbours to emergencies." **Participant 5 (Agri-food Technologist)**

"There are early warning systems through the extension officers. Often, small-scale farmers are not aware. When there is a fire, the whole of the farming community responds and will assist." **Participant 6 (Manager Extension Support)**

"We watch neighbouring farmers as there are pests; we must react otherwise it comes to our crops. We must be aware of what is happening around us, otherwise our crop will suffer.'" **Participant 7 (Women Co-operative leader)**

"We respond fast and speak to neighbouring farmers for help." **Participant 8 (Potato Board)**

"*They do respond speedily but have no support to access resources."* **Participant 9 (Community Development Practitioner 1)**

"We react to heat warnings quickly to get our animals into cover. There is no early warning system. The only way for us to respond is through listening to the news about

the rain and heat on radio and television." **Participant 10 (Rural Co-operative leader)**

"We respond and act fast to crises. Only weather reports warn us of rain. The main sources of information for us are WhatsApp groups and the internet used to google information." **Participant 11 (Female farmer)**

The qualitative findings are consistent with the literature in that they can communicate more quickly on social media by adopting digital technology, which can boost their ability to respond to environmental or economic concerns. Although some respondents felt they needed to be quicker, small-scale farmers react rapidly to disasters.

Natural resources and vulnerability are intertwined since many natural disasters have the potential to wipe out small-scale farmers who depend on agriculture for their livelihood. The principles and ideas of Corporate Social Responsibility and Sustainable Supply Chain Management form the basis for the district Agro-Food Hub in accordance with the suggested framework. As a result, they can expand sustainably and produce value through alternative, sustainable routes. This paradigm is developed with the adoption of digital technology into the concept of an "e-community," which connects small-scale farmers to react quickly. The e-community concept allows for a direct connection between rural and urban locales (see section 2.5).

6.3.6 Scale Qualitative Results

The quantitative results are supported by the qualitative findings from the interviews, as participants acknowledged that incorporating digital technology into their AVCs can improve the scale attribute. Participants in the interviews emphasised that small-scale farmers are adaptable and look for new, creative methods to improve their practices.

The interviewees indicated that they were ready to establish their communal markets. The participants also mentioned how cooperatives offer the chance to sell items jointly and look for niche markets with a positive social impact. The majority of participants believed that there are currently no institutions supporting them as they strive towards growth.

The following quotes from the interviewed participants support the above views on the Scale attribute that impacts the resilience of small-scale farmers.

"We have a farmer-led initiative to provide market access for organically grown and freshly harvested vegetables with a social impact." **Participant 2 (Urban Co-operative Leader)**

"Co-operative market is needed that is run and owned by the local small-scale farmers." **Participant 3 (Trust Board Member)**

"She doesn't know about institutions on different government levels that work with us to scale." **Participant 11 (Female farmer)**

"They are already selling directly to a market in the local area, and they do not have to go through the big dealers. One person has 29 pigs after starting with a few." **Participant 13 (Community Development Practitioner 2)**

The qualitative findings support the need for small-scale farmers to integrate to achieve economies of scale to take advantage of value chain opportunities (see section 2.1). Small-scale farmers in South Africa generally lack economies of scale, and the lack of adequate agricultural land, credit, technology and other resources adversely affect their ability to produce enough food (Malan, 2018). Economic growth depends on innovation in digital technology uptake. When implementing difficult technologies at scale, acceptance and familiarity are crucial considerations (FAO et al., 2020). Enterprise architecture encourages consolidation, reuse and scale economies by addressing goals holistically across all IT initiatives (see section .2.5.4).

Everyone has access to opportunities and benefits without endangering the capacity of future generations to meet their needs (Heeks, 2016). The results corroborate previous research that demonstrated that sustaining sustainability is a significant challenge for digital technology solutions targeted at small-scale farmers. Digital technology services targeted at small-scale farmers and operating in informal, dispersed supply chains are periodically underutilised and do not scale up as much as expected. Although there are many optimistic examples of positive impacts, they are typically not scaled up to the extent anticipated (see section 2.9). The D4D guiding principles were created to provide moral direction for the use of digital technology. Through a working group, implementers, practitioners and donors created it. It offers sound advice that can work as a guideline as the effects of D4D are examined. One of the nine guiding principles is 'Design for Scale' (PDD, 2021).

The paradigm suggests that DASKHs at district level can enhance and scale up small-scale farmers' sustainability to reach a global audience. Farmers continue to exercise their economic plans independently and autonomously. Farmers work together to achieve a common strategic goal at various levels of integration and coordination. The idea includes a framework built on concepts that stress economies of scale in the logistics and marketing operations, while a sustainability approach broadens the options for local food access (see section 3.8).

6.3.7 Diversity and Flexibility Qualitative Results

The qualitative analysis was consistent with the quantitative findings, and the participants who were interviewed agreed that adopting new technologies into AVCs greatly increased the diversity and flexibility of small-scale farmers' traits, which can increase their ability to withstand the effects of climate change and economic hardships.

Participants noticed that the majority of small-scale farmers are flexible and eager to learn. The majority of participants agreed that small-scale farmers typically view change as an opportunity and aspire to become financially stable. The majority of the participants also agreed that they are very eager to develop new solutions and learn how to deal with economic and climate change concerns.

The following remarks from the participants who were interviewed provide credence to the opinions expressed above regarding how diversity and flexibility affect small-scale farmers' resilience and how they are eager to learn from digital technology adoption in AVCs if it strengthens their resilience.

> *"When I have challenges with my crops, I am prepared to do something different. As vegetables were not growing in the heat, a cooler shaded area was found to grow these vegetables. I adapt well to change. I look at options to do things differently from the past. I see change as an opportunity."* **Participant 1 (Young Female Farmer)**

> *"We are very diverse and flexible and want to expand."* **Participant 2 (Urban Co-operative Leader)**

> *"They are flexible and diverse and prepared to process in terms of compliance. Sources of information and institutional barriers to getting land differ for various communities. They see change as an opportunity."* **Participant 3 (Trust Board Member)**

"I am prepared to do things differently as I have done in the past. I get my information from the extension officer. I see change as an opportunity. Climate change has a big impact that you cannot stop it, and I have to work around it." **Participant 4 (Male Farmer)**

"They see change as an opportunity." **Participant 5 (Agri-food Technologist)**

"They are very flexible as their main objective is to make a profit. They diversify and are open to change." **Participant 6 (Manager Extension Support)**

"We diversify quickly and are flexible as change in the farming environment is constant. We always seek innovative means to farm. We see change as an opportunity." **Participant 7 (Women Co-operative leader)**

"We are forced to adjust to change. There are a lot of small-scale farmers that do not want to change and need education and training." **Participant 8 (Potato Board)**

"They adapt well to change. They look at other options to better themselves and do things differently. They see change as an opportunity." **Participant 9 (Community Development Practitioner 1)**

"We are open to change. We always want more information and get this from farming magazines." **Participant 10 (Rural Co-operative leader)**

"We react positively to change. We see change as an opportunity." **Participant 11 (Female farmer)**

"They want to expand to commercial faring as some of them could make it but do not have enough support." **Participant 12 (UN-FAO Representative)**

"They are willing to learn and adapt well to change. They do identify options to do things differently as what they did in the past." **Participant 13 (Community Development Practitioner 2)**

Qualitative interviews revealed that there were serious issues with small-scale farmers being treated unfairly in comparison to commercial farmers. The results of the interviews demonstrated that despite these problems, people are still incredibly diverse and flexible.

Digital technologies can enable small-scale farmers to transition their AVCs into collaborative digital models that are more adaptable and resilient. While local silo-based approaches usually fall short of selecting the best digital solutions and reaping the biggest benefits, collaboration is essential. (see section 2.8). The degree to which a system is institutionalised is determined by its four characteristics: autonomy, flexibility, complexity and coherence. This determines the adjustments that must be done for objects to survive and have an effect on their environment (Peters, 2000). An actor-network, according to Bencherki (2017), is a varied collection of individuals and objects where a number of other actors must also act for one actor to perform. In these networks, actors are treated similarly and have an equal amount of potential agency and power.

This is in line with the Sustainable Livelihoods Framework, which contends that in the context of vulnerability, patterns, shocks and seasonality can either create or destroy assets. The structures and rules of the changing organisations' processes have a considerable impact on access to assets. Yet, how these institutions and procedures change may be influenced by the small-scale farmers' power over them. Those who own and have access to more assets have more options and the freedom to move between several methods. Since diverse resources are required to achieve various livelihood outcomes, small-scale farmers must have access to resources to become sustainable (Ashley & Carney, 1999).

6.3.8 Equity Qualitative Results

The qualitative findings supported the necessity for small-scale farmers to be consulted and involved while adopting digital technology in their AVCs, which was similar to the quantitative findings. The qualitative phase provided evidence in favour of the equality claims that most small-scale farmers use participatory decision-making. The majority of participants agreed that there is a critical need to address gender equity and that youth and women should be given more authority. Yet, the participants who were interviewed thought that decision-making is not always a participatory process. This operated against the involvement of stakeholders, which was necessary to obtain support, come to an agreement, settle disputes and lessen user resistance.

The participants believed that stakeholder support for digital technology in AVCs was strengthened via consultation and involvement. The consultation was also considered a means of enhancing stakeholder communication during the introduction of digital technologies in

AVCs. Small-scale farmers were unfairly treated and ostracised, which decreased trust in the government and impeded the use of digital technologies in agricultural projects. Trust is essential to the success of programmes involving the use of digital technology, even when cooperation from many stakeholders is required. When new technology is placed on small-scale farmers without their approval, they might fight back.

The following quotes from the participants who were interviewed provide credibility to the opinions expressed above regarding how equality affects small-scale farmers' ability to remain resilient.

> "*Our voice is not always listened to when decisions regarding us are made.*" **Participant 1 (Young Female Farmer)**
>
> *"There is participatory decision making between us. The board leads but needs to properly consult members when decisions are made. The constitution is drawn up by all members of the cooperative. The youth are unemployed, have no other income and at least learn some skills, get some knowledge, and get some money if they sell their produce."* **Participant 2 (Urban Co-operative Leader)**
>
> *"Participation depends on how farms are set up and the people that are in charge. There is a difference within groups and disparity within gender as well."* **Participant 3 (Trust Board Member)**
>
> *"80 % of farmers the Agro-technology station works with are females. When working with females, there is always a close relationship with the youth."* **Participant 5 (Agri-food Technologist)**
>
> *"There is not enough gender parity. Small-scale farmers are treated equally in terms of their needs. There is a big gap between different groups of farmers. Youth is more flexible. The men seem to get more assistance. There should be a special focus on assisting youth and women. Still a patriarchal society although there is a lot of women in the industry, they are in the background and the men are in the frontline."* **Participant 6 (Manager Extension Support)**
>
> *"Sometimes not all of us are consulted about when decisions about us are taken."* **Participant 7 (Women Co-operative leader)**
>
> *"There is no time to get together and be consulted when decisions are made."* **Participant 8 (Potato Board)**

"They do participate in decision making but the problem is that there are political agendas that create divisions." **Participant 9 (Community Development Practitioner 1)**

"The decisions get taken in a participative manner." **Participant 10 (Rural Co-operative leader)**

"Participative decision making takes place." **Participant 11 (Female farmer)**

"Their decisions are participatory as they consider the needs and contributions of all the farmers when making decisions." **Participant 13 (Community Development Practitioner 2)**

The findings from the qualitative phase are in line with the literature in that they emphasise the importance of participatory processes for decision making when developing small-scale farmers. As they need to have the ability to select the lives they value, it should be targeted via participatory project design, participatory monitoring and evaluation approaches (Kleine, 2010). The major objectives of inclusive development are the decrease of inequality and the development of the most disadvantaged sections of society. By fusing local indigenous wisdom with modern information, equal opportunities are established in situations of exclusion (see section 3.4).

Implementing development projects, community involvement and cooperation is necessary to gain the trust of small-scale farmers. Farmers need to be involved in the development of technological solutions (Bayer, 2018). The main forces behind novel agricultural systems should be small-scale farmers and gender-sensitive research and development (DAFF, 2018). They are developed by involvement in more structured groups, many of which call for adherence to norms, punishments and regulations that are mutually or broadly agreed. Participatory approaches must be used to determine user preferences. With an assessment of the individual level as a starting point, this can be used to investigate and develop initiatives to reduce poverty or inequality (see section 2.4).

Giving women and young people access to digital technology adoption in AVCs is essential to develop and apply sustainable ones for small-scale farms. Digital technologies enable women and young farmers to have better access to information on how to increase agricultural productivity, as well as linkages to funding and market opportunities (Bayer, 2018). There needs to be a strong political intent to expand small-scale agriculture in rural areas. This includes collaborating with rural women, indigenous communities, young people and other marginalised, at-risk populations (FAO, 2015).

To create an interconnected, inclusive and equitable global food system, nations should promote policies and practices that provide opportunities to small-scale farmers, rural families, women and young people (Begashaw et al., 2019). The framework suggests including women and young people in the foundation layer. The concept argues that in order to create solutions for small-scale farmers' AVCs to embrace digital technologies, there must be cooperation, farmer participation and state accountability (see section 3.6).

6.4 New Emerged Themes Qualitative Results

The hybrid approach, which combines the inductive and deductive approaches, was the coding used. The study began with a deductive approach using the set of codes and themes from the quantitative approach. In addition, the inductive approach was used to develop some new codes and themes when working through the data using inductive reasoning. This was because the code set was not rich enough to represent the depth of the qualitative data.

The arbitrary interpretation and culturally particular message of the facts constitute a theme. A theme is a red thread of underlying meanings that connects related bits of data and enables the researcher to answer the question "why" by offering an explanation (Braun & Clarke, 2006). The new themes that developed included 'Impact of Climate Change and Economic Challenges', 'Lack of government support and transformation', and 'Institutional support towards Digital for Development'.

6.4.1 Impact of Climate Change and Economic Challenges Qualitative Results

The qualitative phase showed that crops and animals perish due to the high heat brought on by climate change. The majority of those surveyed concurred that any global economic crises also have an impact at regional, national and local levels. The participants also said that because of the heat, they must use more water for their animals and crops.

The majority of participants indicated that there was little training or knowledge of government policy for extending support for economic or climate disasters. They argued that local governments should be strengthened so that small-scale farmers are given more support.

Participants pointed out that during calamities, the government typically supports commercial farmers first.

The participants also highlighted that the need to address climate change is too expensive. Although a few attended climate change training, they feel it is too little and that they need continuous training and local support. Participants further added that some are trying to use fewer chemicals to farm. The following quotes from the interviewed participants support the above views on how the use of digital technology can assist in providing more support to build the resilience attributes of small-scale farmers.

> *"Temperature is affecting crops. No finance to buy shading cover to shield the crops. A week before they may have enough to supply the following week, then some of the crops are destroyed by heat."* **Participant 2 (Urban Co-operative Leader)**
>
> *"During Covid-19, the impact was that they were far from outlets and had no transport. The systemic view is that what happens globally affects, regionally, nationally and locally. Structural effects of external markets are controlled by multinational monopolies. Climate change training has taken place. Sponsors withdrew access to nursery seedlings and grant funding for water tanks and generators made available for small-scale farmers for irrigation purposes. Funding takes forever to reach farming communities. They are given funding for a tractor, but no fuel to run it. Climate change has a big impact on incidents of drought."* **Participant 3 (Trust Board Member)**
>
> *"Climate changes are forcing me to go to other seeds. I cannot use a different seed to plant because the seeds for climate change are too expensive, and I do not have the financial muscle. In the case of one farmer, he received an application form for funding from the Extension Officers that was due the next day. When he submitted the form the next day, he was told it was too late and must wait another 2 years for the next funding cycle."* **Participant 4 (Male Farmer)**
>
> *"Economic impacts of price increases caused by climate change are considered and felt by small-scale farmers. Climate change is not something they think about. They complain about funding but constantly move forward."* **Participant 5 (Agri-food Technologist)**
>
> *"Climate change affects both small-scale farmers and commercial farmers and results in job losses. Farmers are motivated to save and to prepare for these challenges. Policies do not reduce risk but put a lot of pressure on small-scale farmers to comply*

as Environmental Impact Assessments (EIAs) and water registration makes it difficult. It is difficult to provide infrastructure (roads and sheds) that is required because of limited funds." "The Department's budget is small and not enough to go around. In case of bad weather or drought, they find it hard to access the feed immediately as it is first provided to commercial farmers." **Participant 6 (Manager Extension Support)**

"We do not know about any policies or laws that mitigate these climate change challenges. In my view, we are affected by climate change, as when it rains during winter, there is lots of water that cause soil erosion and then during summer, there is a drought when that water is needed. There is no infrastructure to mitigate climate change. Our housing and infrastructure are very vulnerable to climate change and economic challenges.' **Participant 7 (Women Co-operative leader)**

"We are working with Potato SA to try reduce the use of chemicals. Resources for climate change are spent mostly on commercial farmers. There was a challenge posted by the government that potato farmers are using too much water. The immense heat in sandveld forces us to keep the potatoes cool." **Participant 8 (Potato Board)**

"Climate change has a big impact as the animals die of the heat." **Participant 9 (Community Development Practitioner 1)**

"There was some climate change training, but it was not enough. We need more continuous support and training as things are changing constantly. Kids are aware and talk about climate change which means they are taught about it at school." **Participant 10 (Rural Co-operative leader)**

"The housing and farm infrastructure are very vulnerable as when it rains, a lot of water runs to and spoils some crops. Climate change has a big impact. The sun is much warmer and sometimes harms the crops." **Participant 11 (Female farmer)**

"Climate change has a big impact. When there was drought and too little water, there were not enough resources made available for small-scale farmers.' **Participant 12 (UN-FAO Representative)**

"We have only experienced some drought and there were not enough resources made available for us. Institutions working with us are normally the Dept of Agriculture on a National and Provincial level. There needs to be more co-ordination on a local municipal level as most farming land is owned on this level." **Participant 10 (Rural Co-operative leader)**

"Climate change has a big impact. They struggle with the heat and need some shading. They do not know about any policies that mitigate climate change or economic impacts.

There is no training or awareness on climate change or economic impacts and thus do not consider it. No physical infrastructure or measures have been adopted for small-scale farmers to prevent damage in case of climatic and economic disasters." **Participant 13 (Community Development Practitioner 2)**

Qualitative interviews revealed that there were significant worries about how climate change, economic hardships and natural catastrophes will affect small-scale farmers. Due to economic constraints and climatic change, smallholder farmers find it nearly impossible to survive. Small-scale farms must become lucrative, commercial enterprises, and their linkages to expanding food markets must be strengthened in order to address the issues of rural poverty and vulnerability (Begashaw et al., 2019). The use of digital technology can result in less water being used because of better management of the environment, energy and climate. It provides a thorough and long-term plan to help people become more resilient to the consequences of natural and economic disasters (see section 3.3).

Global development challenges are intertwined with concerns about rural poverty, agricultural productivity and environmental protection. To manage the interdependencies and interconnections that increase this complexity, sustainable resource use and poverty reduction must be encouraged (Campion, 2018). The main objective is to develop the enabling policy environment to increase investment capital into businesses and projects that promote climate-smart agriculture (FAO, 2018). Small-scale farmers' sustainability are improved and scaled up by DASKHs at district level to reach a worldwide audience (see section 3.8).

Digital technology-based interventions can result in positive, ecologically sustainable outcomes. These tactics lead to a more efficient utilisation of resources and inputs. Also, they reduce food waste, greenhouse gas emissions, and other negative environmental effects. (El Bilali & Allahyari, 2018). With an emphasis on local economic development and environmental sustainability, the proposed framework ensures that rural and urban development are complimentary. Furthermore, it emphasises local buying of goods and services to encourage local entrepreneurship, support it, and advance an environment that is supportive to economic development (see section 3.7)

6.4.2 Lack of government support and transformation Qualitative Results

With interviewed participants confirming the existence of unfairness, marginalisation, coercion, and power politics when small-scale farmers desire to obtain resources from the government, the qualitative analysis was consistent with some of the quantitative findings. Participants stated that because those who benefitted in the past are still benefitting, the government has failed to achieve its transformation goals to create a more just and more equitable society in South Africa. Participants stated that when it came to allocating resources after economic or climate crises, commercial farmers were perceived as more significant and were given preference.

The participants in the interviews brought up the fact that they occasionally do not have their land or enough land to farm. The majority of those who owned land agreed that larger parcels of land and subsidies were necessary for them to become commercially viable. Programmes for land reform are doomed to failure because of a lack of support. The participants concurred that they require assistance in obtaining funding and creating new markets.

Several of the participants also agreed that because there has always been unequal resource allocation, the government is not doing enough to combat inequality. According to several of the participants in the interviews, the government's mentorship programme hurts small-scale farmers because it is run by commercial farmers. Water Boards control the supply and monopolise the high cost of water. Agricultural monopolies are pushing them to use specific products and when they speak out, they face persecution.

Participants made the observation that some Extension agents lack cultural sensitivity and neglect to provide follow-up assistance following training, which is frequently held away from the farm. Participants concurred that there are not enough institutions visiting, which results in a lack of knowledge of government training and policy. The few institutions that do travel concentrate on the same problems and offer insufficient aid during droughts. The study of water conservation techniques has become of paramount importance.

Although the continual load shedding prevents networks from functioning, the qualitative phase supported the idea that small-scale farmers may employ digital technologies to increase their resilience attributes. Eskom, the government-owned sole electric provider, is expensive and unreliable. Small-scale farmers must start experimenting with alternate energy sources to cut costs in order to lessen their reliance on electricity from Eskom.

The following quotes from the interviewed participants support the above views on how the use of digital technology can build the resilience attributes of small-scale farmers.

> "*There are gaps between different groups of farmers.*" **Participant 1 (Young Female Farmer)**
>
> *"Main problem is the availability of land. We start in the yard. Use schools and open spaces, clean dumping sites, test soil, and work to improve the quality of the soil and plant." "The issue of water, as it is scarce during summer. Department of Agriculture donates seedlings, working equipment and once gave some training on pest control. Policies are a grey area. We buy seedlings, put in some hard work, and sometimes get no income. Some do buy covers to shield the crops, but it gets stolen." "Load shedding has created problems as there is no network."* **Participant 2 (Urban Co-operative Leader)**
>
> *"Informal sector underpinned the viability and vitality of the Formal Sector. Holds the community together. They do not have enough land to farm. Need bigger sizes to become commercially sustainable. A farm we support in the Western Cape is the only small-black owned farm in the vicinity and is treated as an outcast. They are only assisted in the case of a fire that could have harmed the neighbouring farms. Apartheid mentality still exists in that farmworkers cannot be entrepreneurs." "Do not know of laws or policies. Issue of crime as insurance fees are high. Extension officers only interested in the technical aspect and not the human aspect. Get people from the community to train, that is, those committed to the community (Train the trainer). Need to be culturally sensitive." "External problems include load shedding that causes problems on chicken farms and to run water pumps, generators are needed which include the extra paid for fuel. Airconditioning and cold storerooms switch off during Load shedding. Can't use cell phones. They use WhatsApp groups for fires. Training and Access to laptops then Load shedding causes there to be no network."* **Participant 3 (Trust Board Member)**
>
> *"There are institutions, but they do not visit enough. When there are good rains, small-scale farmers can go forward but they still need the support of the government which is very weak. Extension officers are not helpful; they come to ask a lot of questions and that is the last you see of them. I only see them 2-3 times a year. Thus, the support of the government is non-existent. I am prepared to react to any crises, but there is no physical infrastructure or resources to assist me."* **Participant 4 (Male Farmer)**

"There needs to be more engagement and more constant support for small-scale farmers." **Participant 5 (Agri-food Technologist)**

"Commodity organisations play a role in terms of transformation. Small-scale farmers need to link up with these organisations to access these opportunities. They do not have access to credit." "Drought in the West Coast District 2014-2017 where feed was provided to the livestock." "Cell networks do not work when there is load shedding." **Participant 6 (Manager Extension Support)**

"We have no capital, and thus we must start farming on small pieces of land. On the other hand, if we get bigger land, the challenge is to produce for the market and sell our produce. There are gaps between the different groupings of small-scale." **Participant 7 (Women Co-operative leader)**

"National Government focus on other provinces in terms of transformation but in the Western Cape, there is no real change. Different focus by National and the Western Cape governments. Pesticide and Fertiliser consultants determine what pesticide you need and then inform and try to force you to use a certain fertiliser. As a PLAS farm, we have a lease of 30 years, and we get recapitalisation funds, but it is much too little to cover all the recapitalisation of assets as well as operational cost. Small-scale farmers are left with no equipment, and you must be profitable within 3 years. You are then called a failure. In the past years, farmers were supported not to fail. Access to help from the government does not exist, and it is hard to be accepted by established groups. We cannot leave our farming practises for training purposes which are often far away from us. When Potato SA have trials with new cultivars, they pass small-scale farmers. When you speak ou,t you are side-lined, and the gatekeepers are recruited. There is a big gap between small-scale and commercial farmers. Small-scale farmers are only allowed to farm on a ½ a hectare or less based on the government's 1 Hectare policy. They need bigger six-12 hectare or even 40-60 hectare to become sustainable commercial farmers." "The issue with Eskom electricity cost is that it is very high. We are investing in renewable energy. They received an inverter with 32 solar panels but no battery to store power. No power to use sprinklers when there is load shedding as inverter needs electricity." **Participant 8 (Potato Board)**

"Small-scale farmers do not have their own land. There is a gap between different groups of farmers.'" "There is no physical infrastructure as the land does not belong to them When there is a lot of rain, there is no cover for the livestock. People cannot watch them all the time, and sometimes they get stolen. They depend on the rain as their

main source of water." "Cell networks is a problem when there is load shedding." **Participant 9 (Community Development Practitioner 1)**

"We want to expand to become commercial farmers as some of us could make it but do not have enough land and support. We only need to be given our own land. This will benefit the Community as we would create economic opportunities outside farming as well. We will work the land, and we will use the successful harvest to create assets for our children. We are attempting to farm organically. We are still impacted by the chemicals and pesticides sprayed by Commercial farmers that surround our farms. Water is a scarce commodity although there is a lot of water. It is controlled by the Water Board, and we must pay a lot of money for water to irrigate. Departments of Rural Development and Water needs to assist. Infrastructure is not available, and the little we have is very hard to maintain because of all the other challenges. Housing for Children on farms is a problem as we are not allowed to expand the housing on our farms. This leads to squatter camps and social ills. There is a big gap between small-scale farmer groupings." "Eskom Electricity accounts are enormous." **Participant 10 (Rural Co-operative leader)**

"There is no physical infrastructure to assist against climate change. There are gaps between us in different groups." "There are a lot of institutions that work on the same issues." **Participant 11 (Female farmer)**

"With the new blended finance, they will need collateral and with the high bank interest, some of them would not be able to make the repayments. There is a big gap between small-scale and commercial farmers as the role of commercial farmers is considered more. Government Mentor programs do not work as they oppress small-scale farmers with the objective of them not to succeed." **Participant 12 (UN-FAO Representative)**

"They are struggling to get feed for animals. There is a big gap between small-scale groups." "The area where they keep the stock is not secured and next to a provincial highway. They are prone to theft of livestock. No secure fence is a disaster on its own as accidents happen on the Provincial Highways often with cows seeking grazing on the other side of the road." "ICT as a tool has improved communication but when there is load shedding, they are unable to connect to cell networks." **Participant 13 (Community Development Practitioner 2)**

The qualitative findings supported the lack of government support for transformation in South Africa is frequently characterised by issues of diversity, coercion, oppression and politics. The majority of participants said that the large commercial farmers that benefitted from prior discriminatory laws and policies continue to do so. The involvement of the state in governance and institutional support is crucial to enable the participation and collaboration of small-scale farmers. This will result in a more equitable distribution of power and wealth among the participants in AVCs (see section 3.1).

The findings also supported literature that articulates that inequality in development persisted after Apartheid ended because large-scale, subsidised white farmers, supermarket chains and other agribusinesses competed with unsubsidised black small-scale farmers (DAFF, 2016). Digital technology adoption in AVCs can benefit the powerful and wealthy more than it does the disadvantaged. Hence, through unfavourable inclusion, disparities in the economic, political and social sectors only get worse. The integration of African small businesses into digitalised global value chains is an example of unfavourable incorporation, in which leading companies in the global North benefit at the expense of those small businesses (Heeks, 2020).

The research also demonstrates the possibility of eradicating global inequality through collaboration among the corporate sector, governments, communities and civil society (Pepper & Jackman, 2019). According to Graham (2019), the government must constantly assess whether existing inequalities, barriers and constraints are made worse by digital technologies adoption in AVCs of small-scale farmers. Why certain value chain actors earn more than others is a matter for the government to understand. The government should be steadfastly dedicated to funding smart agriculture that , especially small-scale farmers (Kanoktanaporn et al., 2019).

There are numerous laws and policies in South Africa that make an effort to realise the full potential of digital technologies to end poverty and lessen inequality. To address social fairness and injustice, new ethical discussions are necessary. The fundamental issues of unequal access to digital resources, processes, benefits and damages across multiple social dimensions must be addressed (see section 2.2).

6.4.3 Institutional support towards Digital for Development Qualitative Results

The qualitative phase was in line with the literature in that it suggested that the government could make greater use of digital technologies to benefit small-scale farmers with extension services and research services. The qualitative findings confirm the need to enhance their

present extended support and give them access to an early warning system to protect them against catastrophes and other economic issues. The usage of digital technology can also promote the creation of business hubs that can make available collective assets that small-scale farmers alone would not be able to buy. Waste also results from a lack of food processing technology possibilities, so it is critical to modernise the infrastructure for digital technology.
The qualitative phase provided evidence that small-scale farmers' traditional knowledge and indigenous practices may be recorded using digital support and research in order to enhance their resilience qualities. The participants in the interviews stressed the important role that digital technology may play in communication and in the chances for research to improve water quality so that they can grow better crops. They promoted action research, which coordinates research with concurrent implementation to lower production costs.

The majority of participants said that the government provides insufficient resources and advice about climate change. Some small-scale farmers receive some assistance from certain NGOs, but they argue that there is too much redundancy and suggest that NGOs should collaborate to streamline support. Participants in the interviews emphasised the lack of institutional support and training on climate change and economic challenges. On the other hand, even if there is, most participants are unaware of it. Participants also concurred that training sessions for acquiring skills in coping with the effects of climate change ought to be planned closer to small-scale farmers.

The qualitative results also emphasised the necessity for business skills in planning, monitoring, managing finances and completing paperwork. Participants are willing to learn new skills, such as collective management abilities, which they do not currently possess. All 13 participants agreed that small-scale farmers' resilience attributes can be strengthened when adopting digital technology solutions in AVCs.

The following remarks from the participants who were interviewed provide credence to the ideas presented above about how small-scale farmers can develop resilience traits through adopting digital technology solutions in AVCs.

> "*We are in contact with institutions that assist us. We are very vulnerable to crises such as storms and the economic impacts of rising prices. There are some infrastructures to assist in reacting to Climate change. We are in contact with government institutions on a local, provincial and national level that are not based in*

this area. We do have support from some institutions. If there is a crisis the private sector might assist but government takes forever. There is training and awareness raising about climate and economic impacts. It is taught to youth at school. "I do not know about any incidence of Climate change or economic challenges. I shall appreciate any information that can assist me to better face challenges. In the beginning, I struggled but then learnt as I went along." **Participant 1 (Young Female Farmer)**

"Prevention is for people to be trained on what to plant and when. We had some quality assurance training, but we need climate change training as this cannot be ignored." **Participant 2 (Urban Co-operative Leader)**

"Small-scale farmers are geographically dislocated from inputs and markets. Institutions are not supporting them. There is an overlay of institutions. Sometimes it is important for these institutions to work together as you need a collective approach to remove some blockages." "Role of Entrepreneurial Hubs. Equipment that can be rented. A system where assets can be used collectively as communal assets. KZN small-scale farmers formed an Agri-hub and bought a Milling machine to process maize. They learnt how they could mill their own maize. Are on farming WhatsApp groups so that nearby farmers can assist". "University student entrepreneurs can be involved in research and development." **Participant 3 (Trust Board Member)**

"Traditional knowledge/indigenous practices are being lost." "I am in contact with institutions that work with small-scale farmers." **Participant 4 (Male Farmer)**

"Institutions that support them do not really exist. The Agro Food station only creates a type of support from retired knowledgeable people but there is no institutional support." "We need to step backwards to get the fundamentals right. More research and implementation need to be done around this. Provincial Agriculture Department and local institutions do organise a get-together once a year. There is too much talk and little or no implementation." **Participant 5 (Agri-food Technologist)**

"They do have contact with commodity organisations that operate on a provincial and national level. Grain SA, NGOs and Sheep Farming Association are some of the organisations that respond to crises. A section in the department, Land Care advise and assist with soil analysis and a Doctor is the only person who advises on climate change. There are not a lot of organisations that make grants available, except the department. Farmers that do not know about this are not part of training meetings. The first point of contact is through the extension officers. Climate change had a big impact on other areas in terms of the heat creating fires. Farmers were trained to build fire

breaks. When there was drought, farmers were trained to use water more sparingly and to look at alternative ways of farming that use less water. Training in climate change is constantly taking place for farmers and is not aware that this takes place in schools. They do not know how to manage resources if it is allocated to a group of farmers, and this leads to a lack of trust amongst them. They have a challenge in filling in the paperwork and doing administration." "There is specific cooling system infrastructure required for chickens which needs to be provided. The department is constantly seeking innovative ways of developing sustainable infrastructures to reduce cost." **Participant 6 (Manager Extension Support)**

"We are interacting with institutions in the area. There are no institutions working on challenges facing small-scale farmers. There is no training regarding Climate change and economic impacts. We still require more information and support on how to do it." **Participant 7 (Women Co-operative leader)**

"South African Pecan Nut Association and Potato SA had sponsored us in the past. No climate change training as small-scale farmers do not have the time to travel to Cape Town and when they get there, they do not understand anything. Small-scale farmers are good at working on the farm but lack business and finance skills. Training and access to finance are some of the most important support needed." "The Borehole Ph is salty, but the potatoes still came out well, although the yield was not too good. We are busy drilling 2 more boreholes near the mountain as if we want to grow better crops, we need better water quality, with the support of University student research." **Participant 8 (Potato Board)**

"Small-scale farmers are not in contact with institutions that operate in the area. No training or awareness-raising activity about climate change and economic challenges are done." **Participant 9 (Community Development Practitioner 1)**

"The only people who assisted us in the past eres Surplus Peoples Project (SPP). We know about climate change from what we listen to the news and see on the TV. We need training and support in planning as some do not plan, while others do not keep by the plans that were developed." **Participant 10 (Rural Co-operative leader)**

"Traditional knowledge/indigenous practices are not taken into consideration." "There is no training on how to deal with climate change and economic crises." **Participant 11 (Female farmer)**

"Not enough training on climate change or economic impacts. Small-scale farmers cannot leave their farming practises for training purposes which are often far away

from them." "Traditional knowledge/indigenous practices are still being used but technology is causing it to disappear. We need to capture it and integrate it with the use of new technologies." **Participant 12 (UN-FAO Representative)**

"Livestock is sometimes fed by other people and dies. No institutions support the farmers because the lease was not renewed. They need fence to cover at least 20 plots." **Participant 13 (Community Development Practitioner 2)**

The aforementioned quotations imply that there was broad agreement among the participants in the interviews regarding the significance of identifying the institutions required for small-scale farmers to implement digital technology into their AVCs. There is evidence in favour of the idea that problems with small-scale farmers adopting digital technology in AVCs are typically brought on by unfavourable institutional arrangements and cannot be resolved by just generating assets (see section 2.4). The success of digital technology interventions depend on strong institutional backing for political empowerment (El Bilali & Allahyari, 2018). Limited institutional and human capacities are characteristics of the digital divide in agriculture, which could limit advancements. For institutionalisation, the systems approach and participatory approaches are emphasised (see section 3.7).

The qualitative findings indicate that small-scale farmers' AVCs are being impacted by the development of digital technology in numerous ways and that institutional and governmental support is needed to modify how small-scale farmers adopt digital technology in AVCs. This study makes the case that identifying the institutional and governance frameworks goal is the first step in designing a complete plan necessary to guide digital technology adoption by small-scale farmers in AVCs (see section 2.8).

The results are in line with the institutionalisation of this framework and the adoption of the District-Centred Development (DCD) paradigm by the South African government. The idea makes sure that the national, provincial and local levels of government work together as closely as possible. It works with civil society at district level to speed up service delivery (DPME, 2019). The DCD Model is compatible with the institutional setting required to implement the PCPDS (Comprehensive Producer Development Support) for agriculture development. The PCPDS streamlines producer categories, enhances institutional processes and mainstreams participation from vulnerable populations. (see section 3.7).

The qualitative results showed that digital technology adoption in AVCs objectives of small-scale farmers was not always clear. There was always a lack of communication with small-scale farmers when adopting digital technology in AVCs. The qualitative results suggest the need for improved communication with small-scale farmers' stakeholders during digital technology adoption in AVCs. The above quotes support that the interviewed participants value the importance of digital technology adoption in AVCs of small-scale farmers to assist in meeting business objectives and needs.

Digital technology architecture lays a solid groundwork for building platforms that are no longer confined by local institutional environments but instead enable the fusion of knowledge across sectors (Constantinides et al., 2018; Quinones et al., 2017). The creation of digital AVC resilience depends on the identification of system resilience and institutional resilience (Vroegindewey & Hodbod, 2018). The success of digital technology interventions depends on stronger institutional backing for political empowerment, the growth of human capital and income disparity (El Bilali & Allahyari, 2018). This framework suggests the establishment of District Agro-Food Sustainable Knowledge Hubs (DASKHs) and Provincial Agriculture Digital Innovation Hubs (PADIHs) to promote grassroots innovation. The framework creates an innovation ecosystem and encourages small-scale farmers to adopt digital technology in their AVCs, where PADIHs collaborate with DASKHs. DASKHs at district level enhance and scale up small-scale farmers' sustainability to reach a global audience (see section 3.7)

6.5 Discussion

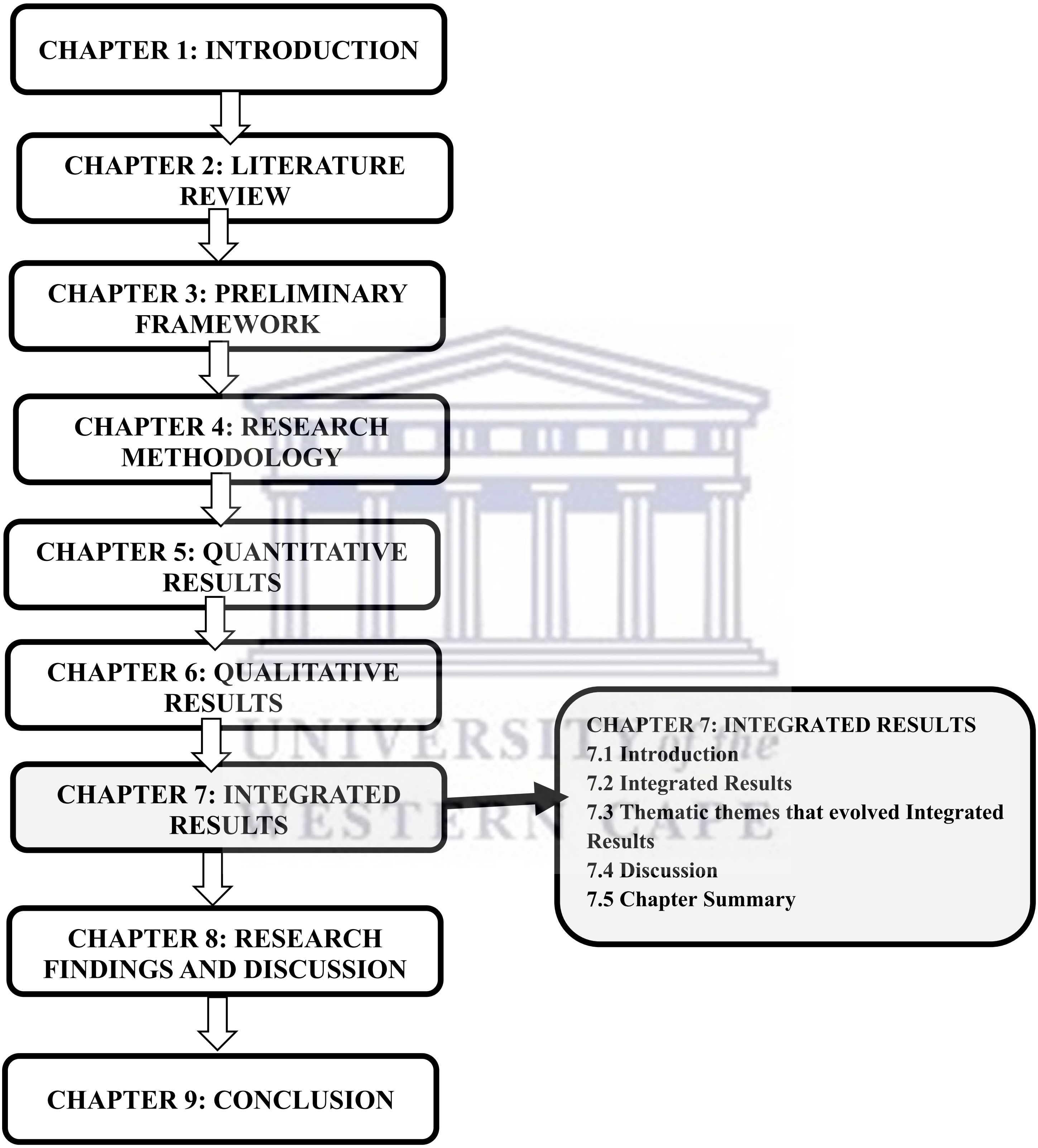
The quantitative findings from the preceding chapter were supported by the qualitative findings. Also, the qualitative phase assisted in providing answers to some of the ambiguous issues raised by the quantitative phase. The qualitative phase provided another dimension by gathering data to justify why the participants' impressions of the adoption of digital technology in small-scale farmers' AVCs were different from those expressed in the quantitative phase. As the study's goal, this was crucial in validating a built framework. The qualitative phase was successful in explaining why participants' perceptions of the adoption of digital technology in small-scale farmers' AVCs varied. As a result, the qualitative phase made the study more comprehensive, which is a benefit of the mixed-methods research strategy.

6.6 Chapter Summary

The qualitative findings from the selected participants' interviews with the interviewed participants were provided in this section. From what the participants said, from the quantitative data and the qualitative results, it was possible to gain a better and more comprehensive understanding of how participants perceived the implementation of digital technology in small-scale farmers' AVCs. Because of this, the sequential explanatory mixed methods research did not just focus on what the participants said—it also examined their motivations. Some of the ambiguous quantitative phase data were resolved, thanks to the qualitative phase.

To analyse some of the contradictory findings from the quantitative phase, it was crucial to conduct interviews with participants to get their first-person accounts of their experiences. The combined findings from the qualitative and quantitative phases of the mixed-methods study are presented in the next chapter. The combined quantitative and qualitative results are crucial for improving the digital value chain framework and assisting small-scale farmers with adopting digital technologies in AVCs.

CHAPTER 7: DIAGRAMMATIC OVERVIEW



7 Chapter 7: Integrated Results

7.1 Introduction

The qualitative results from the preceding chapter were critical and successful in explaining some of the ambiguous results that the quantitative phase was unable to resolve. The study's goal was to create, enhance and validate a digital technology adoption in Agriculture Value Chains (AVCs) framework that would help small-scale farmers. Results from qualitative and quantitative research were combined in a single study, thanks to the sequential exploratory mixed methods research design. To help achieve the planned research objectives, this chapter analyses the combined findings of both the quantitative and qualitative phases. After describing the purpose of the integrated outcomes, this chapter discusses the integrated results. The chapter concludes with a summary of the discussions.

7.2 Integrated Results

The goals of this project were to create, enhance and validate a framework to assist with digital technology adoption in AVCs of small-scale farmers utilising a sequential mixed methods methodology (mixing qualitative and quantitative methods). A mixed methods strategy was employed in the study to gather and analyse both quantitative and qualitative data (sequential explanatory design). The objective of the quantitative phase was to use questionnaire data to assist to establish a more comprehensive picture of participants' perceptions about the usage of digital technologies in AVCs. By addressing the issues raised by the quantitative findings about the uptake of digital technology in small-scale farmers' AVCs, the qualitative phase aimed to contribute to the development of a deeper understanding of the phenomena.

The quantitative results do not fully describe the adoption of digital technology in AVCs affect small-scale farmers on its own. The quantitative data failed to explain why individuals from various demographic groups had differing impressions of the same situation. The narratives were used in the qualitative phase to look deeper into the variations in participant perspectives about the usage of digital technologies in AVCs. The mixed methods research strategy's strength was in its ability to create a comprehensive picture of the difficulties small-scale farmers faced when using digital technology in their AVCs. The integrated outcomes of the resilience attribute variables are covered in the next section.

7.2.1 Robustness Integrated Results

Most respondents' responses to the Robustness construct variables quantitatively placed "report problems and crises" as the variable with the highest ranking and "access weather information" as the variable with the lowest rating. A significant portion of the respondents were unaware because some of them were not exposed to the use of digital technologies in AVCs (see Figure 5-1). Robustness was the resilient attribute with the second-lowest mean score overall (see Figure 5-9). The T-test and analysis of variance (ANOVA) conducted showed a significant difference between Robustness and demographic variables. The t-test results suggest that there are significant differences between the 'gender' variable and Robustness ('access weather information' plus 'report problems and emergencies').

The correlation results suggest that Redundancy, Rapidity, Self-Organisation, Learning, Scale, Diversity & Flexibility and Equity construct variables have an influence on the Robustness construct and are therefore an important part of the proposed framework. In short, the results suggest that if all other constructs improve, it is likely to get positive attitudes on Robustness. The stepwise regression analysis conducted also showed that Robustness had no predictive power over the dependent construct 'Access to Internet'. The results suggest that Robustness construct is not an important component of the proposed digital technology adoption in the AVCs framework.

The qualitative phase supported that small-scale farmers are very robust, motivated, knowledgeable and well informed and can improvise to expand when a project is lucrative. Most participants pointed out that they contribute to sustainable livelihoods and are forced to survive or lose their livelihoods. The interviewed participants highlighted that the use of digital technologies in the AVCs of small-scale farmers can build their robustness and make them more resilient. They further added using digital technologies to communicate and search for information can make them more robust. Most participants expected the use of digital technologies can make their farming better, more efficient, more profitable and more sustainable. The participants added that they expected that digital technologies can assist with more extension support in terms of access to land, funding instruments, inputs and markets.

The quantitative and qualitative results were consistent with the literature on the importance of the perceived usefulness of digital technology adoption in AVCs to enhance the robustness of farmers. As agriculture becomes more knowledge-intensive, new opportunities to offer extension services that are tailored to local conditions arise (Deichmann et al., 2016). Technology is typically associated with swift and occasionally disruptive changes in society and organisations, thus how effective it is in bolstering the resilience of small-scale farmers is subjective. Different people have various opinions about how valuable technology is, depending on how institutions utilise it or how institutions use it (see section 2.5.3).

In addition, the literature mentioned a number of impediments to the small-scale use of digital technology in AVCs that are outside the small-scale farmers' control. The cost to purchase digital technology could restrict the use of digital technology for its economic sustainability and productivity. This implies that the government and other agricultural sector development groups are required to assist for digital technology to be successfully employed in small-scale AVCs (see section 2.2.6).

This explains why the Robustness attribute had the second lowest mean among all the attributes of digital technology adoption in the AVCs framework. The Robustness attribute is more suitable for an individual context rather than a collective context with multiple stakeholders. This is supported by the results in that the Robustness attribute did not correlate with other attributes (see Table 5-5). The perceived usefulness of the Robustness attribute is subjective from a collective context since individuals have different perceptions of the utility of digital technology (see section 2.2).

7.2.2 Self-Organisation Integrated Results

Quantitatively, the highest frequencies of respondents on the Self-Organisation attribute variables; about 61.9 percent of the respondents agreed that digital technology adoption makes it easier to access AVCs as compared to 56.9 percent of the respondents who agreed that digital technologies can assist to build trust amongst stakeholders within AVCs (see Figure 5-2). The quantitative results suggest that the type of occupation had an influence on attitudes towards self-organisation. The correlation results suggest that Self-Organisation attribute variables have an influence on all the other attributes, namely Robustness, Redundancy, Rapidity, Learning, Scale, Diversity & Flexibility and Equity and are therefore an important part of the proposed framework. In short, the results suggest that if small-scale farmers improve all other attributes, they are likely to get positive attitudes on the Self-Organisation of small-scale farmers. The results suggest that there is an association between Self-Organisation and these attributes. The results support the literature that all other resilient attributes of perception can be improved when there is an improvement in the Self-Organisation attribute variables.

The qualitative phase revealed that adopting digital technologies in AVCs of small-scale farmers assists the self-organisation attribute to drive working together and become more resilient. Most participants interviewed felt competition for the few resources available and aspiration to make profits work against the self-organisation attribute. Participants noted that due to sharing the same history, they build trust quickly and generally have good relationships. The participants also highlighted the importance of trust to enhance the self-organise attribute to act as a team for new opportunities. The qualitative phase identified the lack of support for self-organisation and the need for institutions to assist small-scale farmers against the effects of climate change and economic challenges. Most of the interviewed participants felt that they need institutional support to self-organise.

The adoption of digital technology was supported by both quantitative and qualitative findings. According to digital technology adoption in AVC's framework, small-scale farmers cooperate to varying degrees of integration and coordination while pursuing a single strategic objective. (see section 3.8). The findings are consistent with research that emphasises the value of community involvement and collaboration in meeting farmers' information needs (Awuor et al., 2016).

The requirement for better communication with small-scale farmer stakeholders for self-organisation is congruent with this. Due to their fragmentation and inability to generate enough amounts of raw materials to serve small and medium processors, small-scale farmers must be connected through digital technologies to enhance their self-organisation attribute (see section 2.2). Small-scale farmers strongly agree on the significance of self-organisation for the successful implementation of digital technologies in AVCs. Understanding what farmers value by enhancing the self-organisation attribute is essential to making sure that digital AVC solutions are adopted widely and financially successful (Wisdom et al., 2018).

7.2.3 Learning Integrated Results

Quantitatively, most learning construct variables scored low as per participants' responses. Statistically, most of the respondents disagreed or did not know that they had received any training via the internet or exchanged more information about climate change. In addition, the majority agreed to using digital technologies to assist with development in the small-scale farmer community.

The Learning attribute had the highest mean of all attributes of the proposed framework. The analysis of variance (ANOVA) results also indicated significant differences between Age-range and type of occupation with the learning attributes. The results indicated that the different age groups and the type of employment of participants differed significantly in learning. The other demographic variable 'gender' showed a significant difference in the learning attribute. Learning correlated strongly and significantly with all attributes of the proposed framework. The results suggest that changes in these attributes are followed by changes in stakeholder participation (see Table 5-5).

The qualitative findings were consistent with the quantitative results with participants who were interviewed supporting the need to enhance the Learning attribute when adopting digital technologies in the AVCs of small-scale farmers. The interviewed participants noted that they needed continuous education, training and support. They expected to enhance the Learning attribute more when adopting digital technology in their AVCs. Participants highlighted that they were eager to learn and modernise farming practices. The qualitative phase supported that small-scale farmers should get training on how to use digital technologies to build their resilience attributes. Most of the interviewed participants added that online extension support, with online training manuals, was also important to consult regularly.

The quantitative and qualitative results support the literature that there needs to be more emphasis on learning and training, as this is the most important resilient attribute for successful individual technology adoption in AVCs of small-scale farmers (see section 2.2). Research confirms that small-scale farmers encounter numerous challenges when implementing digital technologies, including a lack of knowledge and training (Bayer, 2018). One of the main goals of institutionalisation is to prepare academic institutions to internalise training and curriculum development (Anandajayasekeram, 2011). The goal for sustainable rural lives, according to Carney (2002), is increased access to training. The comprehensive framework that has been put forth tackles the "how" of training for the adoption of digital technologies in AVCs. To facilitate the training of digital skills, the framework recommends the creation of Provincial Agricultural Digital Innovation Hubs (PADIHs), which will work with iNeSI. Through services like training, the Agro-Food Hub opens possibilities for potential synergies among agricultural Enterprises on a local district level (see section 3.7).

7.2.4 Redundancy Frequencies

Statistically, redundancy attribute variables scored above average. Most participants felt that they can use digital technologies to assist their neighbours in AVCs and emergencies. Most agreed that they can access resources for emergencies better during disasters (see Figure 5-4). The Redundancy attribute had above the average mean and the second-highest standard deviation of all attributes. This suggests that most participants were not in agreement with most redundancy variables.

The t-test results suggest that there are no significant differences between the 'gender' variable and Redundancy attribute variables. The analysis of variance (ANOVA) results indicated significant differences between the Redundancy attribute and the Age range variable plus the type of occupation variable. The correlation results suggest that Robustness, Rapidity, Self-Organisation, Learning, Scale, Diversity & Flexibility and Equity attributes variables have an influence on the Redundancy attribute. The results suggest that the Redundancy attribute perception can be improved when there is an improvement in these other attributes.

The qualitative findings about the Redundancy attribute confirmed the quantitative findings in that most small-scale farmers require a secondary source of income in order to be sustainable. The participants also mentioned that they rely on their families and fellow participants for support. The majority of those surveyed concurred that while some small-scale farmers do save, it is generally impossible for most of them to do so. They must collaborate because they are reliant upon various sources of money. The quantitative and qualitative findings support the need for alternative livelihoods found in the literature review. Small-scale farmers have the right to alternate means and freedom, and they should use those means and resources to pursue different ends (Sen, 1989).

Small-scale farmers frequently have access to social resources that enhance their capacity for collaboration, help them establish trust and enable them to pursue their objectives of maintaining their livelihoods. The use of digital technology can improve social capital, which directly influences other types of capital and can increase the efficacy of small-scale farmers' incomes and saving rates (see section 2.4). The findings, both quantitative and qualitative, are consistent with literature that suggests the adoption of digital technologies in AVCs can help people discover alternate sources of income. Research indicates that the use of digital technology improves the capabilities and livelihoods of small-scale farmers, fostering economic growth and reducing poverty (Mago & Mago, 2015).

The qualitative findings corroborated the quantitative findings because the majority of those surveyed believed that when small-scale farmers adopted digital technology into their AVCs, it was crucial to establish agreements on many socioeconomic and political issues. Debates between those affected and those interested in the deployment of digital technology in AVCs may be necessary to exchange differing perspectives on the scenario for small-scale farmers. The quantitative and qualitative results were in line with those of the literature review on the Transformative Emancipatory Paradigm (TEP), which claims that TEP provides a way to examine the adoption of digital technology in AVCs of small-scale farmers from various angles while taking reality into account. TEP, therefore, provides guidelines for different perceptions during digital technology adoption in AVCs of small-scale farmers (see section 2.8).

7.2.5 Rapidity Integrated Results

Statistically, rapidity attribute variables scored very high from the participants' responses. Almost all participants believed that digital technologies give you faster access to emergency aid in case of a disaster. Most of the respondents access early warning systems to warn of potential disasters using digital technologies and agreed that digital technologies assist in organising support for disasters. A reliability test was conducted on all attributes using Cronbach alpha and only the rapidity attribute registering 0.6 was below the acceptable level.

The rapidity attribute had the lowest mean and standard deviation of all the attributes of digital technology adoption in the AVCs framework. The lowest mean suggests that it had the least agreement among respondents, and the lowest standard deviation suggests that the respondents had the least varied responses. The analysis of variance showed significant differences between the demographic variable 'Own a mobile' rapidity attribute and suggest that owning a mobile likely agrees with the rapidity attribute of accessing emergency aid faster. The correlation results suggest that rapidity correlates with all attributes of resilience. The results suggest that the attributes have a positive relationship with Rapidity. In short, the results suggest that if small-scale farmers improve all other attributes, they are likely to get positive attitudes towards Rapidity from small-scale farmers.

The qualitative findings were consistent with the quantitative findings as they indicated that implementing digital technologies adoption in AVCs of small-scale farmers supported the rapidity attribute. Although most participants felt that small-scale farmers respond quickly to crises, a few were of the view that they needed faster reactions to deal with climate change and economic challenges. The qualitative findings concur with the literature in that adopting digital technologies can make them communicate via social media when responding to climate change or economic challenges. The framework proposed expands small-scale farmers into an "e-community," which brings together small-scale farmers using digital technology platforms to respond more rapidly (see section 2.5).

7.2.6 Scale Integrated Results

Quantitatively, scale attribute variables scored above average from the participants' responses. Most of the participants agreed that digital technologies make working within groups easier. More than half agreed that digital technologies assist them to become more involved in AVC projects. Of particular importance to the study is the fact that most participants agreed that technologies allowed them to interact more with institutions involved in AVCs.

The correlation results suggest that the Scale attribute variables have an influence on all the other attribute variables of the framework. The results suggest that all the attributes have a positive relationship with Scale, and if small-scale farmers improve all other attributes, they are likely to get positive perceptions of Scale. The t-test results suggest that there are no significant differences between the scale attribute variables and any variables (see section 5.5). This suggests that there was no association between the Scale attribute and any other attribute variable. The ANOVA results also indicated that the scale attribute had significant differences with Age-range and type of occupation demographic variables.

The qualitative findings from interviews support the quantitative results as participants noted that the scale attribute can be enhanced when adopting digital technology in AVCs. The interviewed participants noted that small-scale farmers are open to change and seek innovative ways to do things better, like using the Scale attribute to create their collective markets. This is consistent with literature that suggests that small-scale farmers in South Africa generally lack economies of scale (Malan, 2018). The participants interviewed felt that currently no institutions supported them in working towards scale.

Participants' support for the requirement that small-scale farmers integrate to attain economies of scale and seize value chain opportunities is demonstrated by the qualitative results from interviews, which support the quantitative results (see section 2.1). This is in line with literature that argues that governments must accelerate transformation and scale up small-scale farmers to guarantee access to opportunities and benefits (Heeks, 2016). When implementing difficult technologies at scale, acceptance and familiarity are crucial considerations (FAO et al., 2020). The proposed digital technology adoption in the AVCs framework assists small-scale farmers to scale up their operations at district level to reach a global audience. The framework is built on concepts that stress economies of scale in logistics and marketing operations (see section 3.8).

7.2.7 Diversity and Flexibility

The responses from the participants gave the diversity and flexibility attribute variables very high quantitative scores. Almost all the respondents agreed that small-scale farmers have more opportunities thanks to modern digital technologies adoption in AVCs. In a similar vein, a large majority of respondents concurred that digital technology facilitated innovation that raise the living standards. Most of the people who were interviewed concurred that opinions are more clearly understood and that knowledge of emerging digital technologies affects the development of AVCs decisions.

The frequency results show that most respondents agreed on most variables of the Diversity and Flexibility attributes that the highest score. This supports the literature that digital technology adoption in AVCs of small-scale farmers creates more opportunities. The ANOVA results indicated significant differences between diversity & flexibility attribute variables and ‘Age-range’ plus ‘type of occupation’ variables. However, further correlation analysis revealed that Diversity and Flexibility attributes had an association with other attributes, suggesting that it is an important component of the proposed Digital technology adoption in the AVCs framework (see Table 5-5).

According to the interviewed participants, the adoption of digital technology significantly improved the diversity and adaptability of small-scale farmers, which was consistent with the quantitative findings of the analysis. Digital technology can enable them to transform their AVCs into collaborative digital models that are more adaptable, agile and sustainable (see section 2.8). Participants remarked that the majority of small-scale farmers are receptive to new information and identify opportunities for change. They are eager to address the economic and climate change challenges.

The quantitative and qualitative findings are in line with studies in the literature that emphasise autonomy, flexibility, coherence and complexity as the four characteristics that define how institutionalised a system is. This determines the adjustments that must be made for structures to endure and influence their environment (Peters, 2000). Nonetheless, the degree to which small-scale farmers themselves have power over institutions and procedures may have an impact on how diverse and flexible they are. Those who own and have access to more assets have more options and the freedom to move between several methods. Since diverse resources are required to achieve various livelihood outcomes, small-scale farmers must have access to resources in order to become sustainable and flexible (see section 2.4.2).

7.2.8 Equity Integrated Results

Quantitatively, the Equity attribute variables scored average from the participants' responses. Statistically, most of the participants agreed that D4D can help poorer farmers to catch up with the richer farmers. Most of the participants concurred that digital technologies create a sense of belonging to AVCs for small-scale farmers. In addition, the participants supported that they could use digital technologies to inform themselves more about projects and information in the agriculture sector. The equity attribute had the highest standard deviation of the attributes, which suggests the respondents' answers differed the most on this attribute. In summary, the results suggest that although small-scale farmers believe that digital technology can assist them to build their resilience, they have many diverse views about equity when adopting it.

The t-test demographic results suggest that Age range and type of occupation has an influence on respondent attitudes towards equity attributes. The more the type of occupation is exposed to technology and the younger they are, the more the respondent was likely to agree small-scale farmers to enhance the equity attributes by adopting digital technology in their AVCs (see section 5.5). In addition, the ANOVA results also indicated significant differences between Age range plus type of occupation and equity. The correlation results suggest that the Equity attribute variables are aligned and have an influence on all the other attributes of the proposed framework.

The results support the literature in that the components of the framework may complement each other. The quantitative and qualitative results are consistent with findings in the literature which highlight that justice has to do with the fairness that is applied to develop individual traits and combine them with the diverse aspirations of various people to attain their various life goals (see section 2.4.1).

The findings from the qualitative phase are in line with the literature in that they emphasise the importance of participatory processes for the growth of small-scale farmers. Since this group can select the lives they value, it should be targeted via participatory project design and participatory monitoring and evaluation approaches (Kleine, 2010). People are developed by involvement in more structured groups that usually demand adherence to mutually or broadly recognised rules, norms and consequences. Participatory approaches must be used to determine user preferences. Equally wealthy individuals may not always produce similarly since they may have varying capacities for performance for a variety of reasons. With an assessment of the individual level as a starting point, this can be used to investigate and develop initiatives to reduce poverty or inequality (see section 2.4).

There needs to be a strong political intent to expand small-scale agriculture in rural areas. This includes collaborating with rural women, indigenous communities, young people and other marginalised, at-risk populations (FAO, 2015). The reduction of inequality and the development of the most disadvantaged members of society are the main goals of inclusive development. In places of exclusion, equal chances are created by combining local indigenous knowledge with modern knowledge (see section 3.4)

Implementing development projects, community involvement and cooperation are necessary to gain the trust of small-scale farmers. Farmers need to be involved in the development of technological solutions. Giving women and youth access to digital AVCs models is essential for them to develop and execute sustainable small-scale farming (Bayer, 2018). The framework proposes the foundation layer to include youth and women. The framework makes the case for collaboration, farmer participation and the state's responsibility (see section 3.6). To create an interconnected, inclusive and equitable global food system, nations should promote policies and practices that provide opportunities to small-scale farmers, rural families, women and young people (Begashaw et al., 2019).

7.3 Thematic themes that evolved Integrated Results

During the qualitative phase, some new themes evolved from the interviews that were not originally specified. They include ‘Impact of Climate Change and Economic Challenges’, ‘Lack of government support and transformation’ and ‘Institutional support towards Digital for Development’. These themes are integrated into this chapter and discussed below.

7.3.1 Impact of Climate Change and Economic Challenges

Qualitative interviews revealed that there were significant worries about how climate change, economic hardships and natural catastrophes will affect small-scale farmers. The majority of those surveyed concurred that any global economic crises also have an impact at the regional, national and local levels. They continued by saying that the excessive heat brought on by climate change leads them to use more water for farming and kills both crops and animals. The majority of those surveyed believed that small-scale farmers d nott receive adequate funding and that commercial farmers are typically supported first. They require ongoing training and community support, and the cost of the seeds to combat climate change is unaffordable.

The results support the literature in that global development challenges are intertwined with concerns about rural poverty, agricultural productivity and environmental protection. To manage the interdependencies and interconnections that increase this complexity, sustainable resource use and poverty reduction must be encouraged (Campion, 2018). Literature further support that small-scale farms must be made into prosperous and commercial enterprises, and their linkages to expanding food markets must be strengthened in order to address the issues of rural poverty and vulnerability. Due to economic limitations and climatic change, smallholder farmers have a very slim chance of surviving (Begashaw et al., 2019).

Digital technology adoption can reduce water usage because of improved environmental, energy and climate management. It offers a comprehensive and long-term strategy to increase resilience in coping with the effects of natural and economic disasters (see section 3.3). The primary goal is to provide the enabling policy framework for boosting investment capital into climate-smart agriculture. The outcomes of digital technology-based interventions are favourable and environmentally sustainable. These solutions lead to a higher level of resource and input efficiency (El Bilali & Allahyari, 2018).

7.3.2 Lack of government support and transformation

When small-scale farmers seek to access government resources, the results of the qualitative study with participants who had been interviewed acknowledged the existence of unfairness, marginalisation, coercion and power politics. These qualitative findings supported the literature by showing the lack of government support for transformation in South Africa. Following the end of Apartheid, unequal development persisted as large-scale, subsidised white farmers, supermarket chains and other agribusinesses competed against unsubsidised black peasant farmers (DAFF, 2016). Most participants concurred that the big commercial farmers that benefitted from the past discriminatory laws and policies are still benefitting. To enable the participation and collaboration of various players and to share power and economic value more fairly among the actors in the AVC, the role of the state in governance and institutional support is essential (see section 3.1).

Some of the participants in the interviews felt that because commercial farmers are in charge of the government's mentorship and development programmes, small-scale farmers are at a disadvantage. Big Agriculture Industrialists monopolise water through Water Boards, and small-scale farmers face discrimination when they speak out. This aligns with the literature that D4D may benefit the powerful and wealthy more than it does the disadvantaged. Inequalities thus worsen in the economic, political and social realms due to unfavourable integration. The integration of African small businesses into digitalised global value chains is an example of unfavourable incorporation, in which leading companies in the global North benefit at the expense of those small businesses (Heeks, 2020). Participants concurred that there are not enough institutions that support digital technology adoption in AVCs of small-scale farmers. This results in a lack of knowledge of government training and policy.

When utilising digital technologies, a nation's laws and general regulatory framework must be considered (Bayer, 2018). It is necessary to enhance the infrastructure for digital technology adoption in AVCs because there are not enough options for food processing technologies. There are numerous laws and policies in South Africa that try to realise the full potential of digital technologies adoption to end poverty and lessen inequality. To address social fairness and injustice, new ethical discussions are necessary. This is critical given the major issues with the unequal use of digital resources, processes, benefits and damages across multiple social dimensions (see section 2.2).

7.3.3 Institutional support towards Digital for Development

The qualitative phase was consistent with the literature in that government could use digital technology to improve current extension support and provide an early warning system to guard against disasters and other economic challenges. The qualitative findings support that there is a need to increase institutional support such as the establishment of entrepreneurial hubs that can make collective assets available which on their own, small-scale farmers would not be able to afford.

7.4 Discussion

The interviewed participants highlighted that digital technologies can play a big role in communication and opportunities for research to better the quality of water to produce better crops. Participants further agreed that training to obtain skills in mitigating climate change challenges must be scheduled close to small-scale farmers. The qualitative findings also highlighted the need for business skills in managing finance, planning, monitoring and doing paperwork. All participants agreed that digital technology tools can assist in strengthening the resilience attributes of small-scale farmers.

There was strong consensus among the interviewed participants that is aligned with the literature on the importance to determine the governance and institutions necessary for small-scale farmers to adopt digital technology into their AVCs. Challenges with small-scale farmers adopting technology are frequently caused by unfavourable institutional arrangements and cannot be solved by simply creating assets (see section 2.4). The success of interventions using digital technology depends on larger institutional support to promote political empowerment, the development of human capital and to address wealth inequality (El Bilali & Allahyari, 2018). The digital divide in agriculture is characterised by inefficient knowledge interchange, poor information content management and constrained institutional and human capabilities, which could restrict improvements (see section 3.7).

The first step in developing a comprehensive strategy for implementing digital technology in small-scale AVCs is to identify the institutional and governance frameworks required to steer digital technology adoption towards its objective (see section 2.8). The findings are consistent with this framework's institutionalisation that aligns with the South African government's adoption of the District-Centred Development (DCD) paradigm.

The DCD concept ensures greater coordination and cooperation between the national, provincial and local levels of government. The DCD Model is in line with the Comprehensive Producer Development Support (PCPDS) for agriculture to put development into practice. The PCPDS improves institutional procedures, harmonises producer categories and mainstreams vulnerable groups' participation (see section 3.7).

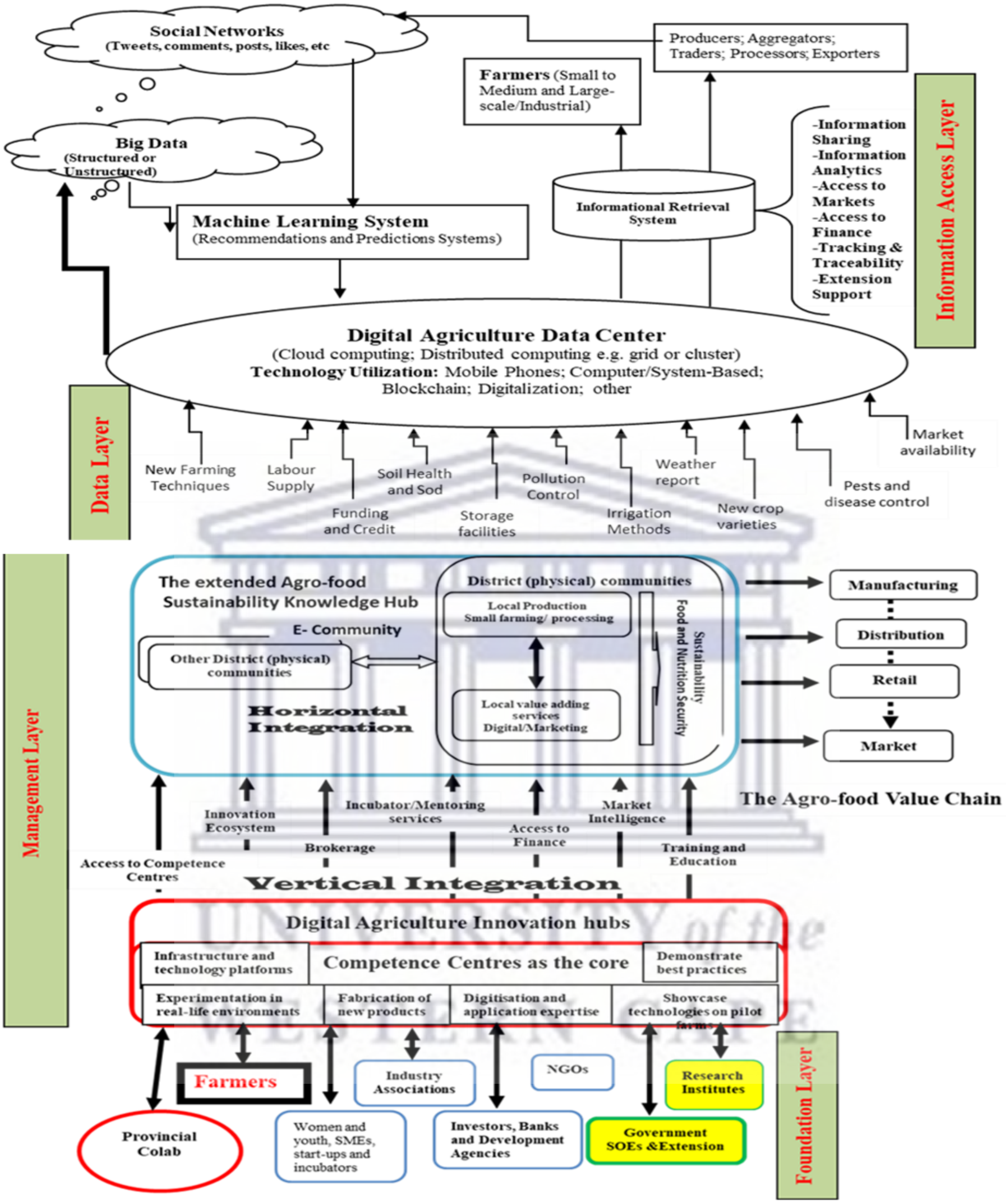


Figure 7-1: Final digital technology adoption in AVCs Framework.

The refined framework (Figure 7-1) advocates for the creation of Provincial Agriculture Digital Innovation Hubs (PADIHs) and District Agro-Food Sustainable Knowledge Hubs (DASKHs) to foster grassroots innovation. PADIHs work with DASKHs to build an innovation ecosystem and support small-scale farmers to adopt digital technology in their AVCs. Small-scale farmers' sustainability is improved and scaled up by DASKHs at district level to reach a worldwide audience. The framework assumption is that different local approaches are well suited for addressing different digital technology adoption contexts in AVCs of small-scale farmers. The Transformative Emancipatory Paradigm (TEP) acknowledges that the one-size-fits-all systems approach does not apply to digital technology adoption in AVCs as it differs according to locality and commodities.

7.5 Chapter Summary

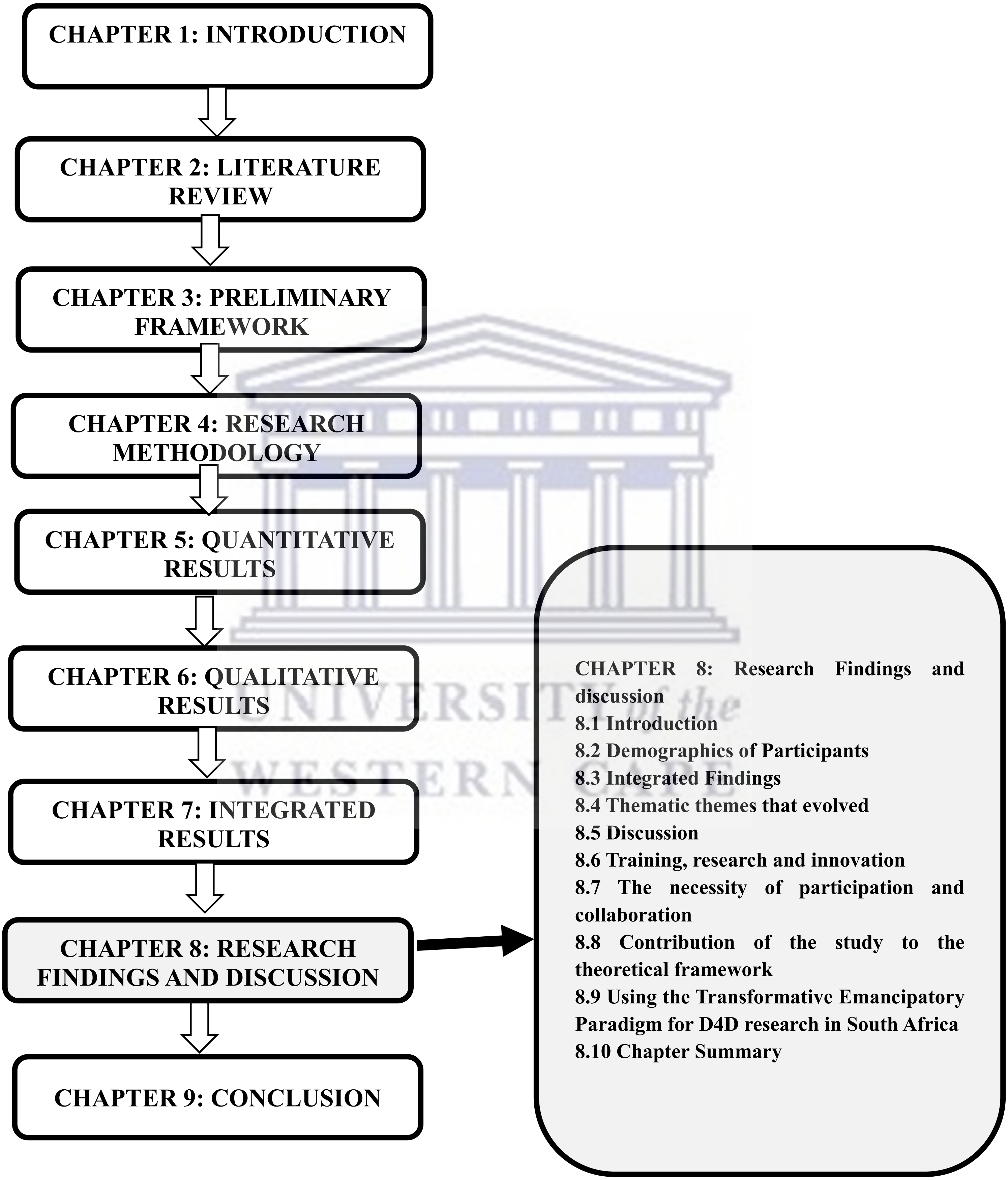
This chapter presents the integrated results of quantitative and qualitative research, focusing on the digital technology adoption in the AVCs framework for small-scale farmers developed in Chapter 3 of the study. The research indicates that institutional and government support are strong predictors of the learning component, suggesting that improving these components may improve digital technology adoption in AVCs.

However, the results also suggest that all the resilience attributes have a strong association with others (see Figure 5-10). This implies that the improvement of anyone has a positive effect on the other of the proposed digital technology adoption AVC framework. The refined digital technology adoption AVC framework is presented after validation using the sequential explanatory mixed methods research (see Figure 7-1).

The integrated results provide a holistic understanding of participants' perceptions of digital technology adoption in AVC for small-scale farmers. The mixed methods research validated the digital technology adoption AVC framework, highlighting the importance of addressing marginalisation and coercion issues. Quantitative results do not fully reveal the challenges faced by small-scale farmers, and the mixed methods approach helped build a holistic picture of these challenges.

The study highlights the complexity of digital technology adoption in AVC for small-scale farmers, requiring a multidisciplinary approach. It suggests that there is no one-size-fits-all approach, as contexts are always different. The framework provides a guideline for small-scale farmer stakeholders to address the complexity using different paradigms. Addressing marginalisation and coercion issues is crucial for small-scale farmers' digital technology adoption. The mixed methods research approach provides a holistic picture of the challenges faced by small-scale farmers.

CHAPTER 8: DIAGRAMMATIC OVERVIEW



8 Chapter 8: Research Findings and Discussion

8.1 Introduction

The purpose of this chapter is to present findings and have a discussion of the main issues that evolved out of the research. The demographics of the participants of both the quantitative phase and qualitative phase are given. A summary of the integrated findings is presented highlighting the thematic themes that evolved out of the qualitative phase. A discussion is then presented emphasising the importance of training, research and innovation. The necessity of participation and collaboration is highlighted. The contribution of the study to the theoretical framework is given and the argument for using the Transformative Emancipatory Paradigm for D4D research in South Africa is made.

8.2 Demographics of Participants

A quantitative survey of 210 small-scale farmers' stakeholders revealed that 70.6% were male, while 29.4% were female. The age distribution showed that 5% were aged 15-25, 13.1% were aged 26-35, 18.8% were aged 36-45, and 63.1% were older than 46. The second phase of the study used a qualitative interview protocol, to select a small number of participants who could provide valuable insights. The interviewee profiles included 13 participants from various organizations, including farmers (3), agri-food technologist (1), agriculture extension manager (1), commodity organization (1), international development NGO (1), agricultural cooperative leaders (3), and community development practitioners (2).

8.3 Integrated Findings

The study used both quantitative and qualitative data to understand participants' perceptions of digital technology usage. The qualitative phase aimed to understand the differences in perspectives among different demographic groups. The mixed methods research strategy provided a comprehensive understanding of the challenges faced by small-scale farmers in adopting digital technology.

8.3.1 Robustness

The Robustness construct variable in the AVCs framework was ranked highest among respondents, with the lowest-rated variables being "report problems and crises" and "access weather information". However, some respondents were unaware of the use of digital technologies in AVCs, and the Robustness attribute had the second-lowest mean score overall. The correlation results suggest that Redundancy, Rapidity, Self-Organisation, Learning, Scale, Diversity & Flexibility, and Equity construct variables influence the Robustness construct. The qualitative phase supported that small-scale farmers are robust, motivated, knowledgeable, and well-informed, contributing to sustainable livelihoods. The use of digital technologies in AVCs can build their robustness and make them more resilient. However, the perceived usefulness of digital technology in bolstering the resilience of small-scale farmers is subjective, and the cost of purchasing digital technology could restrict its use for economic sustainability and productivity.

8.3.2 Self-Organisation

The study found that 61.9 percent of respondents agreed that adopting digital technology makes it easier to access AVCs and helps build stakeholder trust. The type of occupation also influenced attitudes towards self-organization. The self-organization attribute variables have an association with Robustness, Redundancy, Rapidity, Learning, Scale, Diversity & Flexibility, and Equity, which are important attributes for small-scale farmers. The qualitative phase revealed that adopting digital technologies in AVCs helps small-scale farmers become more resilient and work together. Participants felt competition for resources and aspirations to make profits against self-organization. However, trust was found to be essential for self-organization and collaboration. The adoption of digital technology was supported by both quantitative and qualitative findings. Small-scale farmers cooperate to varying degrees of integration and coordination while pursuing a single strategic objective. Community involvement and collaboration are essential for meeting farmers' information needs. Better communication with small-scale farmer stakeholders is necessary for self-organization. Understanding what farmers value by enhancing self-organization is essential for the successful implementation of digital AVC solutions.

8.3.3 Learning

The study found that while most learning construct variables scored low in quantitative results, the majority agreed to use digital technologies for small-scale farmer development. The learning attribute had the highest mean of all attributes of the proposed framework, with significant differences between age-range and occupation. Changes in these attributes are followed by changes in stakeholder participation. The qualitative findings were consistent with the quantitative results, with participants supporting the need to enhance the learning attribute when adopting digital technologies in AVCs of small-scale farmers. They emphasized the importance of continuous education, training, and support, as well as online extension support and training manuals. The comprehensive framework recommends the creation of Provincial Agricultural Digital Innovation Hubs (PADIHs) to facilitate digital skill training and synergies among agricultural enterprises on a local district level.

8.3.4 Redundancy

The study reveals that small-scale farmers often rely on secondary income sources and rely on their families and fellow farmers for support. The adoption of digital technologies in Agri-Villages (AVCs) can help them discover alternative income sources, promote economic growth, and reduce poverty. Digital technology can also improve social capital, directly influencing other types of capital and increasing the efficiency of small-scale farmers' incomes and saving rates. The study found that establishing agreements on socioeconomic and political issues is crucial for small-scale farmers when adopting digital technology in their AVCs. Debates between affected and interested parties may be necessary to exchange differing perspectives. The results align with the Transformative Emancipatory Paradigm (TEP) literature review, suggesting that digital technology adoption can improve small-scale farmers' capabilities and livelihoods, fostering economic growth and reducing poverty.

8.3.5 Rapidity

The study found that the rapidity attribute of digital technology adoption significantly impacts small-scale farmers' ability to access emergency aid and organize support for disasters. The rapidity attribute had the lowest mean and standard deviation among all digital technology adoption attributes in the AVCs framework. Owning a mobile likely correlates with the rapidity attribute of accessing emergency aid faster. The study also found that adopting digital technologies in AVCs supports the rapidity attribute. Although most participants felt that small-scale farmers respond quickly to crises, some needed faster reactions to climate change and economic challenges. The qualitative findings support the literature in that adopting digital technologies can help farmers communicate via social media when responding to these challenges. The proposed framework expands small-scale farmers into an "e-community," allowing them to respond more rapidly to these challenges.

8.3.6 Scale

The study found that digital technologies make working within groups easier and help small-scale farmers become more involved in AVC projects. The scale attribute variables have a positive relationship with all other attributes, and if small-scale farmers improve all other attributes, they are likely to have positive perceptions of Scale. The qualitative findings from interviews support the quantitative results, as participants noted that the scale attribute can be enhanced when adopting digital technology in AVCs. They believe that small-scale farmers in South Africa generally lack economies of scale and feel that no institutions support them in working towards scale. The participants' support for the need for small-scale farmers to integrate to attain economies of scale and seize value chain opportunities supports the quantitative results. Governments must accelerate transformation and scale up small-scale farmers to guarantee access to opportunities and benefits. The proposed digital technology adoption in the AVCs framework assists small-scale farmers in scaling up their operations at the district level to reach a global audience.

8.3.7 Diversity and Flexibility

The study reveals that digital technology adoption in AVCs of small-scale farmers significantly enhances their diversity and adaptability. It facilitates innovation and improves living standards. Knowledge of emerging digital technologies influences decision-making in AVCs. Digital technology can transform AVCs into collaborative, agile, and sustainable models. Small-scale farmers are receptive to new information and eager to address economic and climate change challenges. The study aligns with studies focusing on autonomy, flexibility, coherence, and complexity in institutionalized systems. Access to diverse resources is crucial for achieving livelihood outcomes and becoming sustainable. Overall, digital technology adoption in AVCs supports small-scale farmers in addressing economic and climate change challenges.

8.3.8 Equity

Digital technologies can help small-scale farmers compete with richer ones, creating a sense of belonging and information about agriculture projects. However, attitudes towards equity vary among farmers, with age range and occupation type influencing attitudes. The study supports the literature by emphasizing the importance of participatory processes for small-scale farmers' growth, focusing on participatory project design and monitoring. Participatory approaches should be used to determine user preferences and develop initiatives to reduce poverty or inequality. A strong political intent is needed to expand small-scale agriculture in rural areas, collaborating with marginalized populations like women, indigenous communities, and young people. Inclusive development aims to reduce inequality and develop disadvantaged members of society. Implementing development projects, community involvement, and cooperation is necessary to gain the trust of small-scale farmers. Access to digital AVC models is essential for sustainable small-scale farming, and the framework advocates for collaboration, farmer participation, and the state's responsibility. Nations should promote policies and practices that provide opportunities to small-scale farmers, rural families, women, and young people to create an interconnected, inclusive, and equitable global food system.

8.4 Thematic themes that evolved

During the qualitative phase, some new themes evolved from the interviews that were not originally specified. They include 'Impact of Climate Change and Economic Challenges', 'Lack of government support and transformation' and 'Institutional support towards Digital for Development'. These themes are discussed below.

8.4.1 Impact of Climate Change and Economic Challenges

Climate change, economic hardships, and natural disasters pose significant threats to small-scale farmers, affecting their livelihoods at regional, national, and local levels. They lack adequate funding, require ongoing training, and face unaffordable seed costs. Sustainable resource use and poverty reduction are crucial to manage these interdependencies. Digital technology can reduce water usage and increase resilience in coping with natural and economic disasters, aiming to boost investment capital in climate-smart agriculture.

8.4.2 Lack of government support and transformation

The study revealed unequal access to government resources for small-scale farmers, highlighting the lack of government support for transformation. Post-Apartheid, large-scale white farmers and supermarket chains compete against small-scale farmers. The study found that the state's role in governance and institutional support is crucial for fair power and economic value sharing in the Agribusiness Value Chain. However, some participants felt commercial farmers were disadvantageous due to government mentorship and development programs and faced discrimination when speaking out. The integration of African small businesses into digitalized global value chains worsened inequalities. New ethical discussions are needed to address the unequal use of digital resources across multiple social dimensions.

8.4.3 Institutional support towards Digital for Development

The study suggests that the South African government should enhance digital technologies to benefit small-scale farmers through extension services and research services. This could include early warning systems, business hubs, and modernizing food processing technology infrastructure. Digital technology can also enhance traditional knowledge and indigenous practices, improving resilience and reducing production costs. However, the majority of participants believe the government provides insufficient resources and advice on climate change. Training sessions for coping with climate change effects should be planned closer to small-scale farmers, and business skills are essential. The success of digital technology interventions depends on strong institutional backing for political empowerment, human capital growth, and income disparity.

8.5 Discussion

The primary contribution of this thesis to helping small-scale farmers use digital technology in AVCs is the development and validation of an improved framework for digital technology adoption in AVCs. After a thorough assessment of the literature on the most recent models and frameworks for technology acceptance, the digital technology adoption in the AVCs framework was created. The strengths and shortcomings of existing frameworks were emphasised during the framework's development. As described in Chapter 3, the framework for the increased use of digital technology in AVCs was a synthesis of several models and frameworks. A case study sequential explanatory mixed methods research strategy was later used to validate the initial framework for digital technology uptake in AVCs.

The study found that to handle the complexity of digital technology adoption, a framework to support small-scale farmers' AVCs adoption of new technologies needs to be holistic. So, the study makes the case that adopting digital technology is a complicated process that may call for a multidisciplinary approach. Earlier strategies that had an overly simplistic viewpoint helped resolve more straightforward structuralist problematic situations. Nevertheless, they are unable to deal with the extraordinarily complicated issues that surround the use of digital technology in AVCs of small-scale farmers.

The study demonstrated the need for a multi-approach to a complex problem context surrounding the adoption of digital technology by demonstrating that one solution does not apply to all problem scenarios. So, it is important to recognise that diverse problem situations call for various systems methods rather than viewing the diversity of these approaches as a crisis.

AVCs for small-scale farmers will benefit from the framework for digital technology adoption that has been designed. The study acknowledges that it is crucial to include stakeholders with various worldviews during the introduction of digital technology for small-scale farmers to profit from it. The study makes the case that before small-scale farmers adopt digital technology in AVCs, it is important to understand the nature of the problem surrounding its adoption. The study's findings suggest that the Transformative Emancipatory Paradigm (TEP) is crucial for comprehending small-scale farmers' use of digital technology in AVCs problem situations. The study acknowledges that in order to comprehend the political-socio-economic framework, it is necessary to analyse the adoption of digital technology in the context of AVC's dilemma from the perspective of TEP. As a result, governments and developmental organisations are cautioned that adopting digital technology does not require a one-size-fits-all strategy.

To establish a viable intervention method, the proposed framework for digital technology adoption in AVCs recognises the constraints faced by small-scale farmers in AVCs. TEP offers suggestions for picking the best strategy for the current problem circumstance. The various systems techniques are applicable for various problem settings of small-scale farmers' adopting digital technologies in AVCs. The framework created encourages the participation of stakeholders throughout the adoption of digital technology by small-scale farmers in AVCs. Also, the framework encourages employing the best strategy for the current issue and permits an iterative process in which ideas are tried out in a challenging situation.

The need for the agriculture sector to increase output with fewer resources creates the opportunity for digital technology to continue to facilitate and influence innovations in farming (Ungerer et al. 2018). Agriculture value chains are under more scrutiny driven by concerns over food safety and sustainable production (Kanoktanaporn et al., 2019). Small-scale farmers’ importance in emerging markets like South Africa is recognised globally and increased collaboration in Africa can lead to more integration across AVCs (Ungerer et al., 2018). The agriculture sector relies heavily on research to adapt to changes in the regulatory environment and market requirements. The government must support research as it remains the key source of innovation (DAFF, 2018). Thus, the next section continues this discussion on training, research and innovation.

8.6 Training, research and innovation

The ability to transfer research information into practical products and services is one of the three essential components of innovation, along with the ability to market products and services through commercialisation, communication and service provision (Anandajayasekeram 2011). Small-scale farmers and gender-sensitive development research should be the primary drivers of innovative systems in the agriculture industry (DAFF, 2018).

Driving the uptake of technology in AVCs can be accomplished using the Diffusion of Innovation (DOI) concepts. When an invention is successfully employed economically, that is innovation. Invention, translation or realisation, commercialisation and adoption are the four activities involved in innovation. The innovation may consist of brand-new ideas, products, techniques, works of art, items developed by individuals, works of science or a synthesis of knowledge already known (Anandajayasekeram, 2011). As soon as new verified technologies are made accessible, the research community should communicate their availability, advantages and integration (Ungerer et al., 2018). Thus, if the proper institutions are in place to support the innovators, innovation can move very quickly.

The four factors of independence, flexibility, intricacy and consistency are what determine how institutionalised an organisation is. This dictates the changes that organisations must undergo in order to survive and have an impact on their surroundings (Peters, 2000). One of the main goals of institutionalisation is to prepare academic institutions to absorb research and innovation, as well as to train many significant stakeholders (Anandajayasekeram, 2011). The next subsection discusses the need for stakeholders to collaborate and participate in research, innovation and training aspects when digital technology is adopted in the AVCs of small-scale farmers.

8.7 The necessity of participation and collaboration

Small-scale farmers in South Africa require the same access to resources and opportunities as large commercial farms. Ensuring small-scale farmers are commercially productive and produce for a profitable market is the first necessity (Ungerer et al., 2018). To draw in investment, small-scale farmers must work with investors and financial institutions (Campion, 2018). As a result, they must vertically integrate and choose which aspects of their operation are best supported via collaborations.

Agriculture technologies will be adopted and used more widely if they are designed with the user in mind (Campion, 2018). To impact aspects that were previously out of their control, collaboration gives small-scale farmers greater visibility and foresight along AVCs. This makes it possible for collaborations to facilitate better participation in distribution channels (Ungerer et al., 2018). To understand what drives farmers and how to use and promote the adoption of new technology, it is crucial to have a thorough awareness of the local culture. Sometimes, benefits from science and the economy are insufficient to promote such practices (Campion, 2018).

Small-scale farmers will have to work collaboratively more in the future in areas other than agriculture. The operations of all stakeholders must benefit from the collaboration, and the participants' ambitions must be universally acceptable, aligned and not in conflict between themselves. The legal and governing standards must permit proper leadership, transparent governance and continual open and sincere dialogue.

8.8 Contribution of the study to the theoretical framework

Every scientific theory begins with an opinion that is occasionally correct or incorrect. A theory exposes illusion and informs the truth. To conduct better D4D research an understanding of philosophy, social theory, and information systems is necessary for researchers. As a result, we must tackle this from a philosophical paradigm perspective that draws on systems information thinking and social theory.

This study is situated in the field of digital development and investigates how digital technology adoption can foster the development of the small-scale agriculture sector in South Africa. Digital technology intervention’s role in development is not always clear and is often challenged by critical issues associated with social change improvement. By using the

Capabilities Approach (CA) and the Sustainable Livelihoods Framework (SLF) as the development theoretical foundation, the systematic nature of the development process is recognized.

Kleine's Choice Framework (CF) together with the Evaluative Framework (EF), is used as an evaluation framework for this study. The CF and EF that operationalize the CA and SLF were used as a multidimensional theoretical window to examine academic journals and industrial reports from online databases. Incorporated in this was the Diffusion of Innovation (DOI) Theory, Porter's Value Chain and Carroll's Pyramid of Corporate Social Responsibility.

The research findings reveal that political factors, such as the lack of appropriate policies and programs, and inadequate laws and informal regulations, create structural barriers to the use of digital technology among small-scale farmers in South Africa. These barriers include the high cost of purchasing and accessing digital technology, low awareness of its potential for improving sustainability, and insufficient government policies. Implementing policies and programs to establish digital technology hubs could help facilitate the use of digital technology in the small-scale agriculture sector.

Similarly, many types of agency resources can affect a small-scale farmer's level of digital technology adoption, and subsequently, the influence it has on their degree of empowerment. For example, the lack of infrastructure resources can create a hindrance for small-scale farmers to use digital technology. There are also other limitations of various other resources including insufficient financial resources and a low level of literacy that is coupled with a lack of training.

Variations of development outcomes can have different outcomes among participants who share similar structures and agency resources. The CA and SLF has shown that when developing small-scale farmers, the structure (political, social, and economic factors) that exist could influence the choices of small-scale farmers which can lead to certain development outcomes. The development outcomes can make small-scale farmers' agencies better, which can again lead to better utilization of structure. The utilization of structure can also influence a small-scale farmer's agency. How structure and agency interact can produce choices, and such choices can lead to further development outcomes.

For development outcomes to be achieved, there must first exist the possibility of a choice for small-scale farmers. Secondly, they must have a sense of the availability of that choice. Thirdly, they must make use of the option to choose and finally achieve an outcome. When small-scale farmers choose to use or not to use digital technology, it would make them achieve the primary outcome which is the "achievement of choice". These dimensions of choice have an impact on the nature and extent of development outcomes.

Having secondary development outcomes like easier communication and increased knowledge can lead to others such as better access to markets, business ideas and increased income. Thus, achieving development outcomes can increase the capabilities of resources under the agency. If small-scale farmers can increase the achieving of functionings such as easier communication using digital technology, they can impact their resources within the agency and thus increase their potential functionings. Just as some development outcomes influenced agency resources so too, they have the potential to influence structure.

The contribution of institutional theory to the discussion of digital development theories provided insight into the structure and makeup of the institutions required to support small-scale farmers to use digital technology. It demonstrates how these institutions are localized representations of more established ones, eliminating ambiguity and improving the understandability of an organization's actions. The significance of both change and stability in institutions was emphasized to support this theory.

Actor-network theory helps understand the diverse entities and individuals in South Africa's small-scale agriculture sector. It enhanced our understanding of social electronic and digital constructs to comprehend connectivity. Actor-network analysis was applied to investigate the relationships between political actors or institutions in the agricultural discipline. It examined the connections between individuals, groups, and institutions.

Institutional theory focuses on stability, while technologies often involve rapid and disruptive societal and organizational changes. To better understand these phenomena, ADMIT (Architecture Design or Development Methodology for Information Technology) can be used as a decision-making tool for systematically developing robust architecture using design forces, strategies, and lifecycle processes. This methodology defines an architecture development lifecycle, its phases, and processes, and can be used in conjunction with other frameworks like TOE, Institutional Theory, and Actor-network theory.

Entrepreneurship research should shift from theory to practical real-life situations, requiring collaboration between small-scale farmers and universities in South Africa. This requires a modern, relevant, and effective integration of theory and practice, requiring resourceful and well-prepared strategies to navigate diverse interests and expectations.

The Diffusion of Innovation (DOI) paradigm assisted the study in understanding the creation of Digital Innovation Hubs (DIHs) that combine practice and research to promote innovation. DIHs can assist small-scale farmers to leverage digital technologies to grow their enterprises. They offer infrastructure, facilities, and technical know-how. DOI can assist the ideation, development, and manufacturing stages. Instead of emphasizing on technology, they take a pragmatic, "hands-on" approach, concentrating on small-scale farmers. This accelerates the adoption and expands the reach of digital innovations in line with the DOI principles.

Porter's Value Chain helped analyse digital transformation on a small-scale farm, dividing business operations into primary and supporting activities. It focused on sources of competitive advantage and provided an ideal structure for understanding the agriculture sector. The three key value elements investigated were superior delivered value, customer's perceived value, and lifetime value of customers. Digital transformation involves turning data into wisdom in real-time, integrating technology, and fostering a vision of "real-time" throughout the entire value chain for increased productivity and competitive advantages.

8.9 Using the Transformative Emancipatory Paradigm for D4D research in South Africa

Digital technologies have transformed from development tools to platforms for social justice and inequality in developing nations. The transformation emancipatory paradigm aims to enhance equitable outcomes, but research on D4D lacks influence on societal policies and challenges. Understanding D4D philosophy is crucial for improving work quality and leading to necessary transformations. Cooperation between academics and practitioners is essential for D4D. Interactive Participatory Action Research (PAR) is effective in alleviating rural poverty and enhancing agriculture productivity, but user resistance remains a concern. Ethical standards are necessary for digital interventions to address structural inequities and social justice.

To combat the digital divide in South Africa, we must question domination and transform the current situation. A radical humanist paradigm, focusing on power, politics, and oppression, is ideal for research and digital inclusion interventions. TEP's ethical stance guides reality, knowledge creation, and systematic inquiry, empowering participants to control knowledge production and ideas. PAR methods address access to social justice and marginalized groups, making it relevant for studying power structures and inequalities.

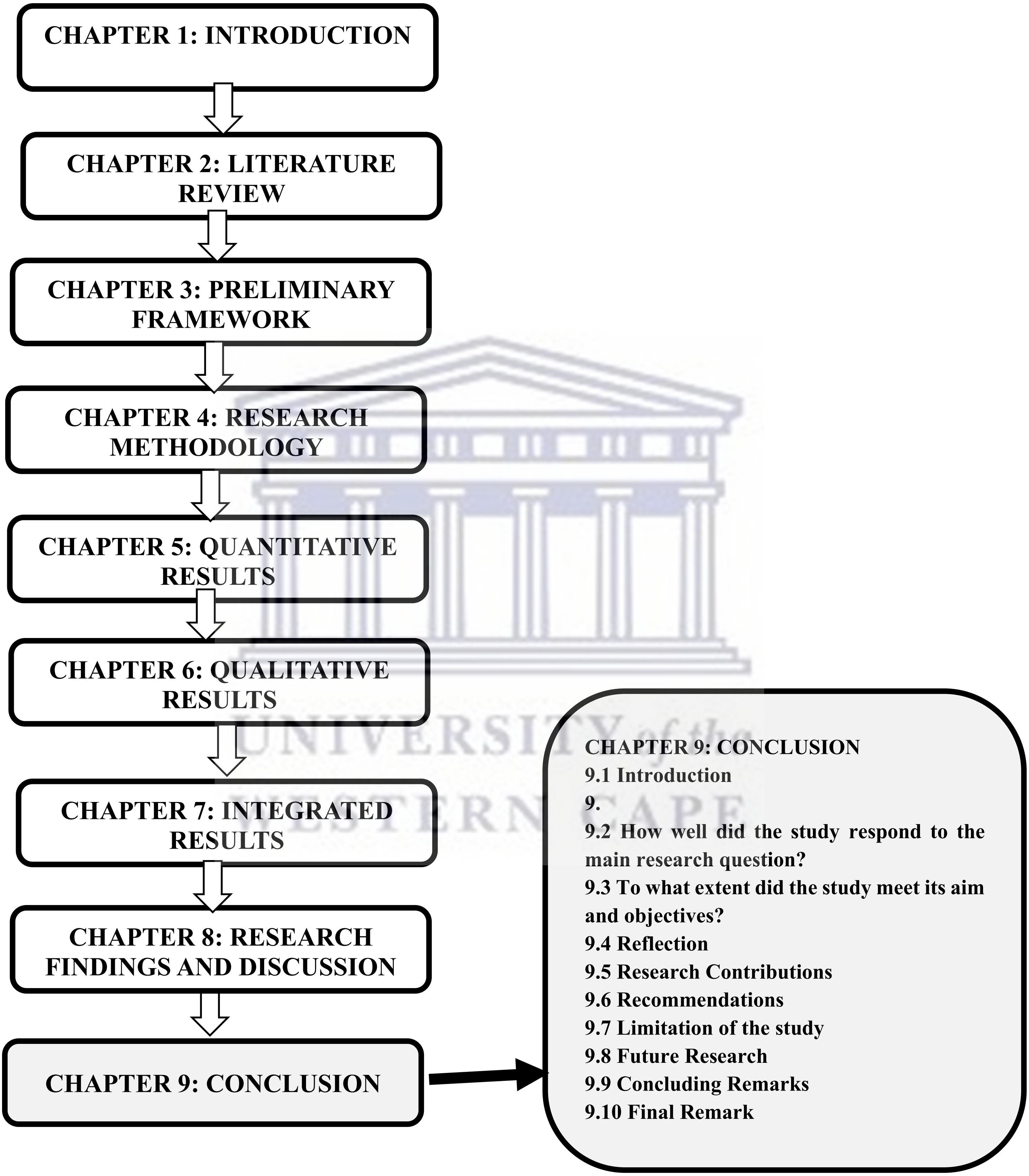
Researchers in South Africa should use the Transformative Emancipatory Paradigm (TEP) to understand the country's socio-economic struggles, characterized by colonialism and apartheid. TEP can help researchers build respectful relationships with all stakeholders, including powerful and less powerful ones. By designing research that can socially and economically transform individual and societal levels, researchers can help emerging black small-scale farmers play a more significant role in the agriculture and food production value chain. Expanding the role of researchers in implementing D4D interventions can contribute to positive social transformation.

D4D, a research paradigm that challenges patriarchal structures and the belief that researchers have absolute knowledge, is being reoriented towards a participatory cyclic process. This shift towards social justice and participation is rooted in human ethical acts and is reoriented towards the essence of being and making. This shift alters the way D4D research is located, offering intervention and preparing future implementers. TEP has the potential to engage and equip vulnerable small-scale farmers living under marginalization and oppression. However, further research is needed to determine the best approach for D4D implementation, including those who agree or disagree with using TEP as a research paradigm for digital justice. This shift is crucial for addressing the challenge

8.10 Chapter Summary

This chapter firstly presents the demographics of participants and a summary of the findings and a discussion of the overall thesis. It presents short summaries of the integrated results, focusing on the resilience constructs. The research indicates that institutional and government support are strong predictors of the learning component, suggesting that improving these components may improve digital technology adoption in AVCs. It further highlights the importance of training, research and innovation pointing out the necessity of participation and collaboration. It further discussed the contribution of the study to the theoretical framework. It concluded by arguing the importance of using the Transformative Emancipatory Paradigm for D4D research in South Africa to address marginalisation and coercion issues.

CHAPTER 9: DIAGRAMMATIC OVERVIEW



9 Chapter 8: Conclusion

9.1 Introduction

The goal of this research project was to improve the framework for helping small-scale farmers adopt digital technology in AVCs by developing and validating it. The study's core research question and supporting questions must be addressed to accomplish these goals. The literature study in Chapter 2 helped to clarify the issues with the existing models and frameworks, as well as the factors that affect small-scale farmers' AVCs' adoption of digital technology. As a guide for Chapter 3's proposal of a framework for digital technology adoption in AVCs, the literature review also helped to provide some insight into how small-scale farmers' AVCs may improve their adoption of digital technology. The creation of enhanced digital technology adoption in the AVCs framework benefitted from the literature review.

Chapter 4 presented and discussed the research methodology used to validate the proposed digital technology adoption in the AVCs framework. The rationale for and applicability of the research methodology to the research problem were covered in Chapter 4. The quantitative findings of the preliminary phase of validating the suggested framework were given and addressed in Chapter 5 of the study. The qualitative findings of the second round of validating the suggested framework were presented and addressed in Chapter 6. Chapter 7 of the study presented and discussed the integrated results of the quantitative and qualitative results of the study. Finally, this last chapter discusses how the study achieved its objectives, answered the research question, study contributions to the body of knowledge, its limitations and areas of further study.

9.2 How well did the study respond to the main research question?

It is important to first know how the study addressed the sub-questions that make the primary research question in order to assess how well it addressed the main research question. As a result, before addressing the primary research question, this section describes how the study addressed the research sub-questions. The first sub-question in the research was:

- **What are the factors affecting the adoption of technology by small-scale farmers in AVCs of South Africa?**

The factors influencing the adoption of digital technology in AVCs of small-scale farmers were originally highlighted in Chapter 2. It also looked at the governance and institutional aspects that should be considered when establishing a policy to encourage the implementation of digital technologies in small-scale farmers' AVCs. This was crucial in determining the requirements for a framework to assist small-scale farmers adopt digital technologies in AVCs. According to the literature, small-scale farmers' AVCs cannot uniformly implement digital technology. To be able to solve various problem scenarios, the framework for digital technology adoption in small-scale farmers' AVCs must be comprehensive. The challenge of embracing digital technologies had an impact on the framework's evolution. The second sub-question for the study was:

- **What are the possible shortcomings of existing digital value chain frameworks that impede small-scale farmers' AVCs in South Africa?**

The study's third chapter assisted in highlighting some of the weaknesses and strengths in the frameworks and models currently used to support the adoption of digital technology by small-scale farmers' AVCs. It was noted in Chapter 2 of the literature review that there are too many variables that influence digital technology adoption in small-scale farmers' AVCs for it to be adequately explained by a cause-and-effect relationship. Quantitative findings from Chapter 5 that demonstrated relationships between the components of the AVCs framework's adoption of digital technology served as additional proof of the thesis. Also, Chapter 2 explicitly stated that the adoption of digital technology by small-scale farmers AVCs was complicated by the differing worldviews of the stakeholders. T-tests (see section 5.3) and analysis of variance (ANOVA) results (see section 5.4) supported the findings, which showed that demographic factors have an impact on the adoption of digital technology in the AVCs framework. The third sub-question in the research was:

- **What are the properties of a digital value chain framework to improve small-scale farmers' AVCs in South Africa?**

The third question was addressed in Chapter 3 of the report, which presented an enhanced framework for small-scale farmers to use when adopting digital technology in AVCs. The preliminary digital technology adoption in the AVCs framework was created by merging existing frameworks to overcome their deficiencies after researching policies and methods used in South Africa. According to quantitative findings, the validation results imply that the resilience attribute variables work well together (section 5.5 – 5.6). The fourth research sub-question was:

- **How could a new digital value chain framework improve small-scale farmers' AVCs in South Africa?**

The validated framework makes it easier for small-scale farmers to adopt digital technology since it provides a comprehensive solution to scenarios when complicated adoption of digital technology in AVCs problems arise. Several digital technology adoption issues are addressed by the framework's numerous components in small-scale farmers' AVCs (see section 7.1). The validated framework's main contribution to promoting digital technology adoption in small-scale farmers' AVCs is its capacity to meet various settings for problem-based digital technology adoption. **To answer the main question:**

- **How can a digital AVC framework assist small-scale farmers in the AVCs of South Africa?**

This framework based on a holistic approach can help small-scale farmers in AVCs use digital technologies so they can tackle various difficult scenarios. Since there is not a one-size-fits-all strategy to small-scale farmers' AVCs using digital technology, a holistic approach will serve as a roadmap to the best response to the problem context. The study's ability to achieve its goals and aims is discussed in the next section.

9.3 To what extent did the study meet its aim and objectives?

This study's main aim was to provide a better digital AVC framework for South African small-scale farmers. These goals were mostly met because Chapter 3 produced the suggested framework based on a thorough literature review. In addition, a case study sequential explanatory mixed methods study was used to validate the framework for digital technology adoption in AVCs of small-scale farmers that was produced in this study. The framework for the adoption of digital technology in AVCs was improved using the combined findings from the quantitative and qualitative phases. The primary goals of this investigation were:

- **To determine the factors affecting the adoption of technology in existing digital AVCs of small-scale farmers in South Africa.**

The study achieved this goal by examining the literature review in Chapter 2, the quantitative findings from participant surveys in Chapter 5, and the qualitative findings from participant interviews in Chapter 6. The literature review assisted in determining the advantages and disadvantages of the current frameworks. The participants' needs throughout the use of digital technology by small-scale farmers were discovered, thanks to the quantitative results. Some "why" questions from the quantitative phase were addressed by the qualitative interviews. The mixed methods research was crucial in gaining a comprehensive understanding of a small-scale farmer's needs through the adoption of digital technology in AVCs.

- **To propose a conceptual digital value chain framework to assist small-scale farmers in the AVCs of South Africa.**

This study met this objective in that it explored and evaluated existing frameworks as part of Chapter 2 in the literature review and Chapter 3. The evaluation was part of understanding the strengths and weaknesses of existing frameworks in assisting small-scale farmers during digital technology adoption in AVCs.

- **To develop an improved digital value chain framework to assist small-scale farmers in AVCs of South Africa.**

The study met this objective in that it developed a preliminary framework in Chapter 3 based on the extensive literature review from Chapter 2. The preliminary framework was developed from a combination of existing frameworks. The combination of existing frameworks meant that they could complement each other's weaknesses.

- **To validate the developed digital value chain framework to assist small-scale farmers in AVCs of South Africa.**

The study met this objective in that the developed framework in Chapter 3 was validated using mixed methods research. Chapter 5 performed the first quantitative validation of the framework. The quantitative results, in addition to validation, provided input to the second qualitative interview validation presented in Chapter 6. While the quantitative results helped to answer the "what" questions of validation, the qualitative results helped to answer the "why" questions during the validation of the developed framework. The last validation of the framework was done after the integration of quantitative and qualitative results as part of refining the framework, shown in Figure 7-1. The final validation was important in developing the final framework. The next section discusses reflections on the study in terms of challenges.

9.4 Reflections

This study was very challenging because of the COVID-19 pandemic when the government declared a 'State of Emergency' that restricted the movement of people. This caused me to cancel a lot of my plans and reschedule conducting the survey as I had to adhere to COVID-19 protocols relating to the different levels. Although I tried to use online surveys, it was unsuccessful due to the limited digital technology usage competencies of small-scale farmers. I was introduced to different District Managers of Extension services to assist with the surveys. Although they agreed to participate in the study upfront, most cited the reason that they were busy. This supports the literature that it is not easy to get access to small-scale farmers to conduct research because of several gatekeepers. The number of small-scale farmers' AVCs that participated in this study was therefore limited.

The other challenge was also that it took time to get questionnaires back from participants. However, the interview phase went well, with the participants showing some enthusiasm and being very cooperative during the sessions. The next section discusses the study's contribution to the body of knowledge.

9.5 Research Contributions

The study's primary contribution is the creation and validation of a framework for digital technology adoption in AVCs of small-scale farmers in South Africa. The study contributes to the current body of knowledge in digital development and investigates how digital technology adoption can foster the development of the small-scale agriculture sector in South Africa. Digital technology intervention's role in development is not always clear and is often challenged by critical issues associated with social change improvement. An alternative conceptualisation of a framework for the adoption of digital AVCs is provided in response to the research questions.

The potential benefit of the framework is that it allows decision-makers to view digital technology adoption problem contexts from multiple perspectives rather than taking for granted certain assumptions during digital technology adoption in AVCs of small-scale farmers. The ability of the framework to use more than one approach to a single problem context is a major advantage of the framework as problem situations in small-scale farmers AVCs do not clearly reveal themselves. In addition, the other contributions of the study include 3 publications in peer-reviewed journals, a book chapter and a presentation at a hybrid international conference.

According to my knowledge, this is the first time that RABIT as an assessment tool has been used to assess such a framework. It is also rare to use the Transformative emancipatory philosophical paradigm together with a mixed method research methodology for this type of research.

The results suggest that the study contributes to both theory and practice in D4D in relation to digital technology adoption in AVCs of small-scale farmers. The systematic nature of the development process is recognised. Kleine's Choice Framework was incorporated with various other development and digital technology adoption theoretical concepts to develop a framework for this study. D4D is a new phenomenon and according to my knowledge this is the first time this has been done in the context of D4D of small-scale farmers. The next section presents some recommendations based on the results of the study.

9.6 Recommendations

Several recommendations can be made from the study results.

i. The study recommends the use of the Transformative Emancipatory Paradigm (TEP) to understand the digital technology adoption problem contexts and help select an appropriate systems approach to address the problem situation. TEP is important in selecting the suitable systems approach to the problem situation at hand in AVCs of small-scale farmers.

ii. The study recommends the facilitation of an agricultural digital services sector that creates conducive conditions for small-scale farmers to become commercially sustainable. Provincial Agriculture Digital Innovation Hubs (PADIHs) are responsible for the coordination of research, development, modification curriculum, training and education for digital skills interventions and act as an incubator. PADIHs will have a developmental focus on collaboration and networking amongst a diversity of actors. It is problem-orientated, where the farmer's needs are the main driver. Digital solution services are offered by technopreneurs, advisors and innovation brokers to small-scale farmers.

iii. The study recommends the involvement and consultation of stakeholders during digital technology adoption in AVCs of small-scale farmers to secure their buy-in. The study also recommends the representation of different stakeholders during digital technology adoption in AVCs of small-scale farmers. District Agro-food Sustainable Knowledge (DASKHs) will develop synergies for digital solutions between the main economic sectors of rural areas and strengthen the sustainable development of digital AVCs for small-scale farmers. DASKHs are based at district level and are run and controlled by small-scale farmer stakeholders.

iv. PDAIHs are built on the strong actors of each Province such as Colabs and Mobile application factories that are already established. Thus, it seems reasonable that the funding and business plans of new PDAIHs should be built over those of such centres with the involvement of small-scale farmers. Certain services of PDAIHs that already exist within public programmes should be aligned to existing funding sources rather than starting from scratch.

Finally, the study results point to the fact that there is no one-size-fits-all approach to digital technology adoption in AVCs of small-scale farmers as contexts always differ. It is therefore important to understand the problem context for small-scale farmers in AVCs before selecting an appropriate intervention strategy. This is where the digital technology adoption in the AVCs framework becomes important in selecting suitable strategies for the problem situation at hand. The next section discusses the limitations of this study.

9.7 Limitations of the study

Although the study contributed to the understanding of digital technology adoption in AVCs of small-scale farmers, it has its limitations which need to be acknowledged. One of the major limitations of the study is that it is based on study research areas of the West Coast and Overberg districts in the Western Cape. The survey could have been spread more widely, which would have made it more feasible to generalise the results of the study. The limitation provides an opportunity for further research using a more widely spread survey.

In addition, the other limitation was that the framework was not tested during digital technology adoption but only validated using participants' perceptions based on previous digital technology adoption experiences in the AVCs of small-scale farmers.

The concept of digital AVCs is in its early stage of development and may need additional dimensions that should be considered with implementation. The theoretical lens used needs more detailed development, as there may be additional dimensions that should be considered, and other concepts and relationships needed in such a multidimensional framework. A longitudinal action research study may also be necessary to test the framework during digital technology adoption in small-scale farmers' AVCs. TEP and D4D advocate for participatory action research.

However, despite these limitations of the study, the use of mixed methods research helped to produce credible results not affordable with a single research method. The next section discusses opportunities for future research in digital technology adoption in AVCs by small-scale farmers.

9.8 Future Research

Although there are many hopeful examples of good outcomes, digital technology can only handle some of the challenges faced by small-scale farmers, and it frequently has not been scaled up to the degree anticipated. To create a more comprehensive theoretical framework addressing the adoption of digital technology in AVCs of small-scale farmers, more studies are required. Furthermore, our work can assist future researchers in the field of digital development in planning and prioritising their research. To that end, recommendations are made for several future study areas that seem to have significant gaps and need further investigation.

- Future research needs to investigate critical factors that lead to the effective application of such a framework. This would require policy intervention and supportive legal frameworks that seek PPPs to maximise digital AVC adoption by small-scale farmers for their sustainability.

The proposed framework shows new ways to address financing and knowledge transfer. Through entrepreneurship, small-scale farmers can develop new business models that can increase their income. To enhance farmers' innovation capacities and increase their competitiveness, the following questions are proposed:

- How can innovation initiatives in AVCs be enhanced through continuous research and development of D4D?
- How can the Automation of the Production of Food be integrated with Big Data Information Systems in AVCs?
- How could the Automation of the production of food in AVCs prevent food wastage?
- Which type of institutions are needed to lead in the implementation of integrated automated AVCs in South Africa?
- How do we ensure a more equal distribution of power and economic value amongst all the actors involved in AVCs?
- How do we retain sustainable practices and small-scale farmers' identities when adopting digital technology in AVCs?

9.9 Concluding Remarks

This section presents the main contributions of this study to the theory and practice of digital technology adoption in AVCs of small-scale farmers. The study contributes to the understanding of the complexity of digital technology adoption in AVCs of small-scale farmers. Of importance is the influence of demographic characteristics on stakeholder perception of digital technology adoption in small-scale farmers AVCs. The study, therefore, confirms the importance of understanding different stakeholder worldviews during digital technology adoption in AVCs of small-scale farmers.

The study expands our knowledge of the complexity and importance of reaching a consensus during digital technology adoption in AVCs of small-scale farmers. The study also highlights the significance of the need for an interdisciplinary approach during digital technology adoption in AVCs of small-scale farmers in order to understand problem contexts from different perspectives. Although there have been several studies on digital technology adoption, arguably, not much research has been done on digital technology adoption in small-scale farmers' AVCs. Several studies have focused on individual technology adoption with no attention to technology adoption from a small-scale farmer perspective where many stakeholders are involved.

Many studies overlook the importance of digital technology adoption in small-scale farmers' AVCs, which is complex owing to different stakeholder worldviews. This study reveals some shortcomings of current models and frameworks relating to the complex phenomenon of digital technology adoption in AVCs of small-scale farmers. This study, therefore, provides a deeper understanding of the challenges of digital technology adoption in AVCs of small-scale farmers.

Furthermore, the study also developed an improved digital technology adoption in the AVCs framework to assist small-scale farmers with digital technology adoption in AVCs. The developed digital technology adoption in the AVCs framework has the potential to improve digital technology adoption in small-scale farmers' AVCs. The developed framework based on holistic systems approaches helps to view digital technology adoption problem contexts from different perspectives to find suitable systemic approaches to address digital technology adoption problem in small-scale farmers' AVCs. The developed digital technology adoption in the AVCs framework is expected to improve stakeholder perceptions and digital technology adoption outcomes in small-scale farmers' AVCs.

According to the current study, agriculture stakeholders should focus on environmental, social and ethical practices that are in line with Carroll's CSR pyramid in addition to product quality. To promote sustainable agriculture management practices through vertical integration through partnerships, trade-offs between individual productivity and group sustainability must be negotiated. This study analysed the literature on several frameworks that can aid in the adoption of digital AVCs in order to address this difficulty. A framework for the adoption of a digital AVC was developed after researching the policies and strategies used by the South African government. The framework recommends that DASKHs that are in line with DOI principles be implemented, accompanied by PADIHs that are in line with CSR and vertical integration. At district level, DASKHs can enhance and scale up small-scale farmers' sustainability to reach a global audience. Farmers work together to achieve a common strategic goal at various levels of integration and coordination. PADIHs provide digital services to the agriculture industry with an emphasis on SMEs. Additionally, they provide mentorship services, access to capital, market data, training and education to assist young start-ups grow, thus acting as an incubator.

Recent research highlights the adoption of digital technology in small-scale farmers' AVCs, transforming them into integrated operational models for sustainability. This change improves the unfair terms of AVCs, enabling pre-arranged collaboration and collective use of information and resources. Government and banking sectors should support technopreneurs in improving small-scale farmers through Agri-Tech ideas.

9.10 Final Remark

The properties of a framework to facilitate information technology adoption in small-scale farmers' AVCs must be holistic to address the complex nature of digital technology adoption in small-scale farmers' AVCs. There is no one-size-fits-all approach to digital technology adoption in AVCs of small-scale farmers which requires an inter-disciplinary approach by applying Participatory Action Research (PAR) methods.

REFERENCES

Abbas, A. A. (2018). The bright future of Technopreneurship. International Journal of Scientific and Engineering Research, 9(12), 563-566.

Abbasi, M. (2017). Towards socially sustainable supply chains – themes and challenges. European Business Review, 29(3), pp. 261-303. https://doi.org/10.1108/EBR-03-2016-0045

Action Aid International. (2011). What women farmers need. Action Aid International, Johannesburg, South Africa.

Adeoti, J. O. (2019). Technopreneurship and National Development: Powering Businesses and the Economy with New Technologies. Conference: FUTA 31st Convocation Lecture. Federal University of Technology, Nigerian Institute of Social and Economic Research (NISER), Ibadan18 December 2019.

Adu, P. (2019). A Step-by-Step Guide to Qualitative Data Coding (1st ed.). Routledge. https://doi.org/10.4324/9781351044516

African Development Bank Group (ADBG). (2013). Agricultural Value Chain Financing (AVCF) and development for enhanced export competitiveness, African Development Bank Group, Pretoria, South Africa.

African Union Commission (AUC) and African Union Development Agency (AUDA). (2020). First continental report on the implementation of agenda 2063, African Union Commission and the African Union Development Agency-NEPAD. ISBN: 978-1-928527-22-0. Addis Ababa, Ethiopia

Agri Symposium. (2019). Agri-Symposium 2019 Booklet. Organised By: Agricultural Research Council (ARC), Land Bank, National Agricultural Marketing Council (NAMC), Onderstepoort Biological Products and Perishable Products Export Control Board (PPECB), South Africa

Alampay, E. (2006). Analysing socio-demographic differences in the access and use of ICTs in the Philippines using the capability approach Electronic Journal of Information Systems in Developing Countries, 27(5), 1-39

Alkire, S. (2002). Valuing Freedoms: Sen.s Capability Approach and Poverty Reduction Oxford: Oxford University Press.

Alkire, S. (2005). Capability and functionings: Definition and justification (HDCA introductory briefing note). Human Development and Capability Association (HDCA).

Amadeo, K. and Rasur, E. (2022). Vertical integration: Pros, cons, and examples, Vertical integration is a restructuring strategy, viewed 27 January 2022, from https://www.thebalance.com/what-is-vertical-integration-330.

Anandajayasekeram, P. (2011). The role of agricultural R and D within the agricultural innovation systems framework, in Conference working paper 6 of agricultural science and technology indicator, IFPRI, Prepared for the ASTI/IFRI-FARA Conference, Accra, Ghana, December 5–7, 2011, Washington, DC.

Andersson, A., Grönlund, Å. and Wicander, G. (2012). Development as freedom – How the capability approach can be used in ICT4D research and practice (editorial). Information Technology for Development Journal, Volume, 18(1), 1–4. https://doi.org/10.1080/02681102.2011.632076

Aphunu, A. and Atoma, C.N. (2011). Extent of Use of ICTs by Fish Farmers in Isoko Agricultural Zone of Delta State, Nigeria. Journal of Agricultural Extension, 15(1), Department of Agric. Extension and Management, Delta State Polytechnic, Ozoro.

Archer, E. and Chetty, Y. (2013). Graduate Employability: Conceptualisation and findings from the University of South Africa. Progression, 35(1), 134-165.

Arnstein, S. R. (1969). A Ladder of Citizen Participation, Journal of the American Institute of Planners, 35(4), 216-224.

Asenso-Okyere, W. K., Felix A. A. and Oware L. G. (1993). Policies and Strategies for Rural Poverty Alleviation in Ghana. ISSER, University of Ghana, Accra.

Ashley, C. and Carney, D. (1999). Sustainable Livelihoods: Lessons from early experience. London: Department for International Development.

Awuor, F., Raburu, G., Onditi, A. and Rambim, D. (2016). Building e-agriculture framework in Kenya, Hungarian Association of Agricultural Informatics, European Federation for Information Technology in Agriculture, Food and the Environment, Journal of Agricultural Informatics, 7(1) journal.magisz.org. https://doi. org/10.17700/jai.2016.7.1.244

Babbie, E. (2016). The Practice of Social Research (14th ed). Boston, MA: Cengage Learning.

Baker, J. (2011). 'The technology–organization–environment framework', in Y.K. Dwivedi, L.M. Scott, L. Schneberger and I.S. Systems (eds.), Information systems theory: Explaining and predicting our digital society, vol. 1, Integrated Series in Information Systems 28. University of Hamburg, Hamburg, pp. 232–243. https:// doi.org/10.1007/978-1-4419-6108-2_12

Baker, S. E. and Edwards, R. (2012). How many qualitative interviews is enough? Southampton, UK: National Centre For Research Methods.

Balestrino, A. (1996). “A note on functioning-poverty in affluent societies” in A. Balestrino, I. Carter (eds.), Functionings and capabilities: normative and policy issues, Notizie di Politeia (special issue, n.43/44), Milano.

Barakabitze, A. A., Fue, K. and Sanga, C. (2017). The Use of Participatory Approaches in Developing ICT-Based Systems for Disseminating Agricultural Knowledge and Information for Farmers in Developing Countries: The Case of Tanzania. Electronic Journal of Information Systems in Developing Countries, 78(8), 1-23. DOI: 10.1002/j.1681-4835. 2017.tb00576.x

Barlow-Zambodla, A. and Ferreira, F. (2012). Good Practice in community engagement: A case study of Household Food Security in Eastern Cape. United Nations Development Group, International Development Institute

Bass S., Dalal-Clayton B. and Pretty J. (1995). Participation in Strategies for Sustainable Development. Environmental Planning Group, International Institute for Environment and Development, London, UK

Bayer, J. (2018). Harnessing the chances of digitalisation for rural development: Lessons-learnt in German-funded rural development projects. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH Registered Offices Bonn and Eschborn Sectoral Project Rural Development. https://www.giz.de/fachexpertise/html/3189.html,https://www.snrd-africa.net/

Begashaw, B., Verburg G., Yamauchi F., Fattibene D. and Yasuo F. (2019). Cooperation with Africa G20 Japan: Linking Smallholder Production with Value-Added Food Markets Belay. Policy Brief The Sustainable Development Goals Center for Africa, May 6, 2019.

Bencherki, N. (2017). ‘Actor-network theory’, in C. Scott and L. Lewis (eds.), The international encyclopedia of organizational communication, Wiley, New York, NY. https://doi.org/10.1002/9781118955567.wbieoc002

Bene, C. (2003). When Fishery Rhymes with Poverty: A first Step beyond the Old Paradigm on Poverty in Small-Scale Fisheries. Elsevier Science Ltd., Great Britain.

Berthod, O. (2016). ‘Institutional theory of organizations’, in A. Farazmand (ed.), Global encyclopedia of public administration, public policy, and governance. Springer International Publishing AG. https://doi.org/10.1007/978-3-319-31816-5_63-1

Bhaskaran, C. and Philip, H. (2008). Extension Strategies for Fostering Knowledge Centric Agricultural Growth, In Society of Extension Education, Coimbatore, pp 66–72.

Bhattacharyya, J. (2004). Theorizing community Development. Journal of the Community Development Society, 34(2), 5-35.

Bless, C., Higson-Smith, C. and Sithole, S. L. (2013) Fundamentals of Social Research Methods: An African Perspective (5th ed.). Cape Town: Juta.

Boateng, R., Budu, J., Mbrokoh, A. S., Ansong, E., Boateng, S. L. and Anderson, A. B. (2017). Digital Enterprises in Africa: A Synthesis of Current Evidence, DIODE Network Paper No.2, Centre for Development Informatics, University of Manchester, UK.

Bostock, J., McAndrew, B., Richards, R., Jauncey, K., Telfer, T., Lorenzen, K., Little, D., Ross, L., Handisyde, N., Gatward, I. and Corner, R. (2009). Aquaculture: global status and trends. Philosophical Transactions of the Royal Society of London

Bowles, M. (2016). Leadership in the Digital Economy (Industry 4.0). Institute for Working Futures. Conference: Keynote Presentation, Leadership Foresighting At: Symantec House, Sydney, Australia

Boyatzis, R. E. (1998). Transforming qualitative information: Thematic analysis and code development. Sage.

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77-101.

Braun, V. and Clarke, V. (2019). Reflecting on reflexive thematic analysis. Qualitative Research in Sport, Exercise and Health, 11(4), 589-597. https://doi.org/10.1080/2159676X.2019.1628806

Braun, V. and Clarke, V. (2013). Successful qualitative research: A practical guide for beginners. SAGE Publications.

Brewster, C., Wolfert, S. and Sundmaeker, S. (2012). Identifying the ICT Challenges of the Agri-Food Sector to Define the Architectural Requirements for a Future Internet Core Platform." A Paper delivered at the eChallenges e-2012 Conference Proceedings

Bryman, A. (2015). Social Research Methods (5th ed.). Oxford University Press.

Bryman, A. and Bell, E. (2011). Business Research Methods. 3rd Edition, Oxford University Press, Oxford.

Bukht, R. and Heeks, R. (2018). Digital Economy Policy in Developing Countries, DIODE Network Paper No.6, Centre for Development Informatics, University of Manchester, UK.

Byrne, D. A. (2022). Worked example of Braun and Clarke's approach to reflexive thematic analysis. Qual Quant 56, 1391-1412, https://doi.org/10.1007/s11135-021-01182-y

Cai, Y. (2012). Graduate employability: a conceptual framework for understanding employers' perceptions. Higher Education, 65(4), 457-469.

Campion, A. (2018). Cracking the nut: Promoting agricultural technology adoption and resilience, Connexus, June 15th, 2018, in Antigua, Guatemala at the Hotel Soleil La Antigua. Conference publication. Connexus Corporation in partnership with the Inter-American

Development Bank (IDB), USAID, Feed the Future, Catholic Relief Services (CRS), and Chemonics International.

Carney, D. (1999). Sustainable Livelihood Approaches Compared. London: Department for International Development.

Carney, D. (2002). Sustainable Livelihoods Approaches: Progress and Possibilities for Change. London: Department for International Development.

Carroll, A. B. (2016). 'Carroll's pyramid of CSR: Taking another look', International Journal of Corporate Social Responsibility, 1, 3. https://doi.org/10.1186/s40991-016-0004-6

Carvalho J. Á. (2019). Research and practice in IS: insights from medicine that might contribute to overcoming the relevance deficit in the IS domain, Department of Information Systems, Centro ALGORITMI, University of Minho Campus de Azurém, 4804-533 Guimarães, Portugal, DOI: 10.12821/ijispm070101

Cecchini S. and Scott, C. (2003). Can Information and Communications Technology Applications Contribute to Poverty Reduction? Lessons from Rural India. Department of Economics, London School of Economics & Political Science, Houghton.

Chambers, R. and Conway, G. (1992) Sustainable Rural Livelihoods: Practical Concepts for the 21st Century, IDS Discussion Paper 296, Brighton: IDS

Chilisa, B. and Kawulich, B. (2012). Selecting a research approach: Paradigm, methodology and methods. In C. Wagner, B. Kawulich, and M. Garner (Eds.), Doing Social Research: A global context. London: McGraw Hill.

Chin Lin, A. (1998). Bridging Positivist and Interpretivist Approaches to Qualitative Methods. In Policy Studies Journal, 26(I), 162 -180.

Chukwudi, J. H. and Nwosu J. C. (2018). Entrepreneurship Education and the Challenges of Graduate Employability in Nigeria. International Journal of Innovation Management, 9(5),189-193, DOI: 10.18178/ijimt.2018.9.5.812

Clarke, V. and Braun, V. (2016). Thematic Analysis. In: Lyons, E., Coyle, A. (eds.) Analysing Qualitative Data in Psychology, 2nd edn., pp. 84–103. Sage Publications, London

Comim, F. (2001). "Operationalizing Sen's Capability Approach." Paper prepared for the Conference on Justice and Poverty: Examining Sen's Capability Approach. Cambridge 5-7

Constantinides, P., Henfridsson, O. and Parker, G. G. (2018). Introduction – Platforms and infrastructures in the digital age. Information Systems Research, 29(2), 381-400. https://doi.org/10.1287/isre.2018.0794

Cooper, H. (2010). Research synthesis and meta-analysis: A step-by-step approach, 5th edn., Sage, Newcastle, England

Corallo, A., Latino, M. E. and Menegoli, M. (2018). From Industry 4.0 to Agriculture 4.0: A Framework to Manage Product Data in Agri-Food Supply Chain for Voluntary Traceability, World Academy of Science, Engineering and Technology International Journal of Nutrition and Food Engineering Vol:12, No:5, 2018

Cornwall, A. (2008). Unpacking 'Participation': models, meanings and practices. In Oxford University Press and Community Development Journal, Institute of Development Studies, Brighton BN19RE

Cornwall, A. and Coelho, V. S. (2006). Spaces for Change? The Politics of Citizen Participation in New Democratic Arenas, London: Zed.

Cousins, B. (2011). 'What is a "smallholder"? Class-analytic perspectives on small-scale farming and agrarian reform in South Africa', in P Hebinck and C Shackleton(eds) Land resource reform in South Africa: impacts on livelihoods. Routledge: Abington.

Cousins, B. (2013). Accumulation from below' and the Tugela Ferry irrigation farmers, in Stephen Greenberg (ed), Smallholders and agro-food value chains in South Africa. Emerging practices, emerging challenges. Cape Town: Institute for Poverty, Land and Agrarian Studies, University of the Western Cape (83-89).

Creswell, J. W. (2003). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 2nd ed. Thousand Oaks, CA: Sage.

Creswell, J. W. (2005). Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research. 2nd ed. Upper Saddle River, NJ: Merrill.

Creswell, J. W. (2009). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Thousand Oakes CA: Sage.

Creswell, J. W. (2013). Steps in Conducting a Scholarly Mixed Methods Study. DBER Speaker Series. 48. http://digitalcommons.unl.edu/dberspeakers/48

Creswell, J. W. (2013a). Qualitative Inquiry and Research Design: Choosing Among Five Approaches (3rd). Thousand Oaks, CA: Sage.

Creswell, J. W. and Plano Clark, V. L. (2007). Designing and conducting mixed methods research. Thousand Oaks, CA: Sage.

Creswell, J. W. and Plano Clark, V. L. (2011). Designing and conducting mixed methods research. 2nd ed. Thousand Oaks, CA: Sage.

Cripe, R. (2018). " ICT4D Part 1: History of ICT4D." illuminAid. Accessed September 27, 2020. https://www.illuminaid.org/blog/2018/8/29/ict4d-part-1-history-of-ict4d

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. Psychometrika, 16(3), 297-334.

De Stagé, R., Holloway, A, Mullins, D., Nchabaleng, L. and Ward, P. (2002). Learning about livelihoods. Insights from southern Africa. Oxfam Publishing. Oxford.

De', R. (2007). The impact of Indian e-government initiatives. Regional Development Dialogue, 27(2), 88-100

Dearing, J. W. and Cox, J. G. (2018). Diffusion of innovations theory, principles, and practice. Journal of Health Affairs, 37(2), 183-190. https://doi.org/10.1377/hlthaff. 2017.1104

Debsin (Debsin Technologies Pvt. Ltd.). (2021). What is Technopreneurship? Explain Meaning and business model 2022. The Code Work Available at: https://thecodework.blogspot.com/2021/08/what-is-technopreneurship-explain.html.

Deichmann, U. and Mishra, D. (2019). 'Marginal benefits at the global margins: The unfulfilled potential of digital technologies', in M. Graham (ed.), Digital economies at global margins, pp. 21–24, International Development Research Centre, MIT Press, London.

Deichmann, U., Goyal, A. and Mishra, D. (2016). Will digital technologies transform agriculture in developing countries? Policy Research Working Paper Series 7669, The World Bank, Washington, USA.

Department of Agriculture, Forestry and Fisheries (DAFF). (2016). Transforming the agricultural sector towards an inclusive rural economy, "Food for All and 1 Million Jobs, by 2030", A Concept Document for Operation Phakisa Agriculture, Land Reform, and Rural Development, Version: 30 May 2016, Department of Agriculture, Forestry and Fisheries, Pretoria

Department of Agriculture, Forestry and Fisheries (DAFF). (2018). Policy on Comprehensive Producer Development Support (PCPDS): Draft 5 ver. 3, 30 May 2018, Department of Agriculture, Forestry and Fisheries, Pretoria.

Department of Monitoring and Evaluation (DPME). (2019). Khawuleza District Development Model: Key Messages. Department of Monitoring and Evaluation, South Africa, 2019 https://www.dpme.gov.za/news/Pages/KhawulezaDistrictModel.aspx

Department of Rural Development and Land Reform (DRDLR). (2015). Department Rural Development and Land Reform Strategic Plan, 2015 – 2020. Department Rural Development and Land Reform, Pretoria, Republic of South Africa.

Department of Telecommunication and Postal Services (DTPS). (2016). National Integrated ICT Policy. Pretoria: Department of Telecommunication and Postal Services.

Department of Telecommunication and Postal Services (DTPS). (2017). Electronic Communications and Transactions Act No. 25 of 2002, Notice 887 of 2017, South Africa's

National e-Strategy, Department of Telecommunication and Postal Services, Government Printer, Pretoria.

Devkota P. L. (2000). People Centred Development in Nepal: An Innovative Approach. In Occasional Papers in Sociology and Anthropology - Volume 6, Central Department of Sociology and Anthropology, Tribhuvan University, Kathmandu, Nepal

DFID. (1999). Sustainable livelihoods guidance sheets, Department for International Development.

Didelot, D. (2012). Robotics in Agriculture and related Environmental Issues. Strategic Research Agenda ICT-AGRI, Coordination of European Research within ICT and ERA-Net ICT-AGRI Strategic Research Agenda

Dodel, M. (2015) An Analytical Framework to Incorporate ICT as Independent Variable. in A. Chib, J. May and R. Barrantes (Eds.), Impact of Information Society Research in the Global South (123– 141) Springer Open.

Duncombe, R. (2006). Using the livelihoods framework to analyse ICT applications for poverty reduction through microenterprise. Information Technologies and International Development, 3(3), 81-100

El Bilali, H. and Allahyari. S. (2018). Transition towards sustainability in agriculture and food systems: Role of information and communication technologies. Information Processing in Agriculture, 5(4), 456-464. https://doi.org/10.1016/j.inpa.2018.06.006

Elder-Vass, D. (2019). 'Actor-network theory', in P. Atkinson, S. Delamont, A. Cernat, J.W. Sakshaug and R.A. Williams (eds.), SAGE Research Methods Foundations, Sage. https://doi.org/10.4135/9781526421036766534

Essays, UK. (2018). Research Onion – Explanation of the Concept. Retrieved from https://www.ukessays.com/essays/psychology/explanation-of-the-concept-of-research-onion-psychology-essay.php?vref=1

European Innovation Partnership 'Agricultural Productivity and Sustainability (EIP-AGRI). (2017). Seminar digital innovation hubs for agriculture, Final report October 2017, European Commission, Brussels, Belgium.

Ezeomah B. and Duncombe R. (2019). The Role of Digital Platforms in Disrupting Agricultural Value Chains in Developing Countries. In: Nielsen P., Kimaro H.C. (eds) Information and Communication Technologies for Development. Strengthening Southern-Driven Cooperation as a Catalyst for ICT4D.

FAO and AUC. (2018). Sustainable agricultural mechanization: A framework for Africa. Food and Agriculture Organization (FAO) and African Union Commission (AUC). 127 pp. Licence: CC BY-NC-SA 3.0 IGO, Addis Ababa.

FAO and ITU. (2015). Paving the way to a national e-agriculture strategy. The Technical Centre for Agricultural and Rural Cooperation ACP-EU online discussion on the e-Agriculture Platform.

FAO and ITU. (2016). E-agriculture strategy guide. Piloted in Asia-Pacific countries. Published by the Food and Agriculture Organization (FAO) of the United Nations and the International Telecommunications Union (ITU), Bangkok.

FAO and ITU. (2017). Paving the way to a national e-agriculture strategy. The Technical Centre for Agricultural and Rural Cooperation ACP-EU online discussion on the e-Agriculture Platform by the Food and Agriculture Organization (FAO) of the United Nations and the International Telecommunications Union (ITU), Bangkok.

FAO and RAP. (2012). Mobile technologies for food security, agriculture and rural development: Role of the public sector, Jointly organized by the Food and Agriculture Organization of the United Nations (FAO), Regional Office for Asia and the Pacific (RAP), National Electronics and Computer Technology Center (NECTEC), Bangkok,

FAO, CIAT and AfDB. (2020). Digital Agriculture Profile South Africa. Food and Agriculture Organization of the United Nations (FAO). The Alliance of Bioversity International and the International Center for Tropical Agriculture (CIAT), The African Development Bank (AfDB), Rome, Italy.

FAO, IFPRI and OECD. (2018). Information and communication digital technology (ICT) in agriculture. A report to the G20 agricultural deputies prepared by Food and Agriculture Organization of the United Nations (FAO) with inputs from International Food Policy Research Institute (IFPRI) and Organization of Economic Cooperation and Development (OECD).

Feed the Future. (2014). Information and Communications Technology (ICT) Solutions for Inclusive Agriculture Value Chains, Policy Brief FEED THE FUTURE, The United States Government's Global Hunger and Food Security Initiative https://www.agrilinks.org/sites/default/files/brief_5-ict_solutions_for_agricultural value _chains.pdf

Fleming, S. (2021). The pandemic has damaged youth employment: Here's how we can help. Senior Writer, Formative Content World Economic Forum, Available at: https://www.weforum.org/agenda/2021/07/pandemic-damaged-youth-employment/

Flick, U. (2007). Designing qualitative research. SAGE Publications, Ltd, https://doi.org/10.4135/9781849208826

Fonseca, L. M. (2018). Industry 4.0 and the digital society: concepts, dimensions and envisioned benefits. Proceedings of the 12th International Conference on Business Excellence 2018, Porto, Portugal

Food and Agriculture Organization (FAO). (2005). Assessment: Traceability Technologies and Practices in Food Chains Production and Distribution of Fruits for Export from the Western Cape. Contract: AGS214A9001401, Draft Final Report, 12 June 2005

Food and Agriculture Organization (FAO). (2013). Information communication digital technology (ICT) solutions for inclusive agricultural value chains. Food and Agriculture Organization (FAO). http://www.fao.org/docrep/017/aq078e/aq078e.pdf

Food and Agriculture Organization (FAO). (2015). Achieving zero hunger: The critical role of investments in social protection and agriculture, Food and Agriculture Organization, International Fund for Agricultural Development, viewed 7 June 2020, from http://www.fao.org/3/a-i4777e.pdf.

Foster, C. and Heeks, R. (2015). Policies to support inclusive innovation. Development Informatics, 61, 1-17. Available at https://doi.org/10.1016/0736-5853(84)90003-0.

Fowosire, R. A., Idris, O. Y. and Opoola, E. (2017). Technopreneurship: A View of Technology, Innovations and Entrepreneurship. Global Journal of Research in Engineering: Electrical and Electronics Engineering, 17(7) Version 1.0, Global Journals Inc. (USA)

Foxcroft, C. and Roodt, G. (2019). Introduction to Psychological Assessment in the South African Context (5th ed.). Cape Town: Oxford University Press Southern Africa.

Frei-Landau, R., Muchnik-Rozanov, Y. and Avidov-Ungar, O. (2022). Using Rogers' diffusion of innovation theory to conceptualize the mobile-learning adoption process in teacher education in the COVID-19 era. Educ Inf Technol, **27**, 12811-12838. https://doi.org/10.1007/s10639-022-11148-8

Frye, I. (2005). Constructing and adopting an official poverty line for South Africa: Some issues for consideration. A discussion document for the National Labour and Economic Development Institute, South Africa

Gaiha, R. and Mathur, S. (2018). Agricultural research, digital technology and nutrition in Sub-Saharan Africa, GDI working paper 2018-029. University of Manchester.

Gasper, D. (2007). Human Well-being: Concepts and Conceptualizations. In: McGillivray, M. (eds) Human Well-Being. Studies in Development Economics and Policy. Palgrave Macmillan, London. https://doi.org/10.1057/9780230625600_2

Gaur, K. and Sharma, P. (2020). Technopreneurship: A need for future development of the business sector. International Journal of Research in Marketing Management, 01(02).

Ghasemi, A. and Zahediasl, S. (2012). Normality Tests for Statistical Analysis: A Guide for Non-Statisticians. International Journal of Endocrinology and Metabolism, 10, 486-489. https://doi.org/10.5812/ijem.3505

Gigler, B. (2004.) Including the excluded: Can ICTs empower poor communities? Paper presented at 4th International Conference on the Capability Approach, Pavia, Italy.

Gillespie, J., Kim, S. A. and Paudel, K. (2007). Why don't producers adopt best management practices? An analysis of the beef cattle industry. Agricultural Economics, 36(1), 89-102. https://doi.org/10.1111/j.1574-0862.2007.00179.x

Gliner, J. A., Morgan, G. A. and Leech, N. L. (2009). Research Methods in Applied Settings: An Integrated Approach to Design and Analysis, Second Edition (2nd ed.). Routledge. https://doi.org/10.4324/9780203843109

Global Forum for Rural Advisory Services (GFRAS). (2022). The role of RAS for inclusive agripreneurship: Background and rationale. https://www.g-fras.org/en/agripreneurship.html.

Goddard, W. and Melville, S. (2004). Research Methodology: An Introduction. Claremont: Juta & Company Ltd.

Goodsell, L. (2013). The Interpretive Tradition in Social Science. Draft paper presented at the National Council on Family Relations, University of Utah, San Antonio, Texas, USA

Graham, M. (2019). 'Changing connectivity and digital economies at global margins', in M. Graham (ed.), Digital economies at global margins, International Development Research Centre, pp. 1–18, MIT Press, London.

GSMA (Global System for Mobile Communications Association). (2018). mAgri – Opportunities in agricultural value chain digitisation: Learnings from Uganda, viewed 5 October 2019, from https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/01/Opportunities-in-agricultural-value-chain-digitisation- Learnings-from-Uganda.pdf.

Guba, E. G. and Lincoln, Y. S. (2005). 'Paradigmatic Controversies, Contradictions, and Merging Confluences', n N. K. Denzin and Y. S. Lincoln (eds.) Handbook of Qualitative Research 3rd ed., 191-215. Thousand Oaks, CA: Sage.

Gupta, J. Mirjam A. F. and Ros-Tonen, M. A. F. (2015). 'Inclusive development,'n a book: Encyclopedia of Global Environmental Governance and Politics. Publisher: Editors: Pattberg P.H., Zelli F.

Habiyaremye, A., Kruss, G. and Booyens. I. (2019). Innovation for inclusive rural transformation: The role of the state. Innovation and Development, 10(2), 155-168. https://doi.org/10.1080/2157930X.2019.1596368.

Haenssgen, M. J. and Ariana, P. (2018). The place of technology in the Capability Approach. Oxford Development Studies, 46(1), 98-112, DOI:10.1080/13600818.2017.1325456

Hanson, W. and Heeks, R. (2020). Impact of ICTs-in-Agriculture on Rural Resilience in Developing Countries, Development Informatics Paper 84, University of Manchester, UK. http://www.gdi.manchester.ac.uk/research/publications/di/

Haq, M. (1995). The Advent of the Human Development Report" Chapter 3 from "Reflections on Human Development. Oxford University Press.

Hassan, R. N., Mingers, J. and Stahl, B. (2018). Philosophy and information systems: where are we and where should we go? European Journal of Information Systems, 27(3), 263-277, DOI: 10.1080/0960085X.2018.1470776

Hatakka, M. and De, R. (2011). Development, capabilities and technology: an Evaluative Framework. In IFIP WG9. 4: 11th International Conference on Social Implications of Computers in Developing Countries.

Hati, S.W., Hidayat, R., Kartikaningdiyah, E. and Gunawan, H. (2018). Technopreneur Based Entrepreneurship Development Program as an Effort to Realize the Nationality of Nations in Politeknik Negeri Batam. Journal of Entrepreneurship, Business and Economics, 6(2), 101–114.

Hayes, N. (1997). Doing Qualitative Analysis In Psychology (1st ed.). Psychology Press. https://doi.org/10.4324/9781315804552

Heeks R. (2020a). ICT4D 3.0? Part 1—The components of an emerging "digital-for-development" paradigm. Electronic Journal Information Systems for Developing Countries.; e12124. https://doi.org/10.1002/isd2.12124

Heeks R. (2020b). ICT4D 3.0? Part 2—The patterns of an emerging "digital-for-development" paradigm. Electronic Journal Information Systems for Developing Countries, 86: e12123. https://doi.org/10.1002/isd2.12123

Heeks, R. (2016). 'Examining "Digital Development": The Shape of Things to Come?' GDI Development Informatics Working Papers, no. 64, Manchester, pp. 1-84.

Heeks, R. (2018). Development Implications of Digital Economies, DIODE Network Paper, Centre for Development Informatics, University of Manchester, UK

Heeks, R. (2020). From the Digital Divide to Digital Justice in the Global South. Keynote Web Science Workshop DigDivDigHum-20, Centre for Digital Development, University of Manchester, United Kingdom

Herselman, M. (2003). Where Parallels Intersect. In ICT in Rural Areas in South Africa: Various Case Studies, Informing Science In SITE, Pretoria, Pretoria, South Africa

Horner, R., and Alford, M. (2019). The roles of the state in global value chains: An update and agenda. GDI working paper 2019-036. University of Manchester.

iNeSI (Ikamva National eSkills Institute). (2018). Ikamva National eSkills Institute Bill (As introduced in the National Assembly (proposed section 75), Government Gazette No. 41581 of 20 April 2018, Department of Telecommunication and Postal Services, viewed 16 January 2020, from https://www.inesi.org.za/pages/collaborative-network.php.

Institute of Entrepreneurship Development (IED). 2020. Agripreneurship: The Agricultural Entrepreneurship, Team | 6 March, 2020, https://IED.eu/project-updates/agripreneurship-the-agricultural-entrepreneurship/

International Telecommunications Union (ITU). (2016). ITU-T focus group digital financial services, Impact of agricultural value chains on digital liquidity. ITU, Geneva, Switzerland.

ITU and FAO. (2016). Developing e-agriculture strategy. International Telecommunications Union (ITU) - Agriculture Platform by the Food and Agriculture Organization (FAO) of the United Nations Training, 1–2 September 2016, Nonthaburi. ITU, Geneva, Switzerland

Jackson, T. H. and Weinberg, A. (2016). Impact of agricultural value chains on digital liquidity – Focus group technical report. https://creativecommons.org/licenses/by-nc-sa/4.0/

Jacobs, R. M. (2013). Educational research: Sampling a population. website: www83.homepage.villanova.edu/richard.jacobs/.

Jennings, R. (2000). Participatory Development as New Paradigm: The Transition of Development Professionalism. Prepared for the "Community Based Reintegration and Rehabilitation in Post-Conflict Settings" Conference Washington, DC. October 2000.

Joffe, H. (2011). 'Thematic Analysis,' in D. Harper, & A. R. Thompson (Eds.), Qualitative Research Methods in Mental Health and Psychotherapy: A Guide for Students and Practitioners, Chichester: John Wiley & Sons, Ltd. http://dx.doi.org/10.1002/9781119973249.ch15

Johnson, R. B. and Turner, L. (2003). 'Data Collection Strategies in Mixed Methods Research,' in Handbook of Mixed Methods in Social and Behavioral Research, (pp. 297-320), A. Tashakkori and C. Teddlie (eds.). Thousand Oaks, CA: Sage.

Joiner, J. and Okeleke, K. (2019). E-commerce in agriculture: New business models for smallholders' inclusion into the formal economy. GSMA Head Office.

Jokonya, O. (2016). Towards a Critical Systems Thinking Approach during IT Adoption in Organisations. Procedia Computer Science, 100, 856 – 864. ISSN 1877-0509. DOI 10.1016/j.procs.2016.09.235.

Jokonya, O. (2016a). "The Significance of Mixed Methods Research in Information Systems Research" (2016). MWAIS 2016 Proceedings. 20. http://aisel.aisnet.org/mwais2016/20

Jokonya, O. (2016b). "Building and validating Information Systems Theory using a case study sequential explanatory mixed methods research". PACIS 2016 Proceedings. 218. http://aisel.aisnet.org/pacis2016/218

Juma, C. (2019). 'Digital Services and Industrial Inclusion: Growing Africa's Technological Complexity,'in Graham, M. (ed.). Digital Economies at Global Margins. International Development Research Centre, London, MIT Press

Kaloxylos A. et al. (2013). The Use of Future Internet Technologies in the Agriculture and Food Sectors: Integrating the Supply Chain. Department of Informatics and Telecommunications. National and Kapodistrian University of Athens, Athens, Greece

Kaloxylos, A. (2005). A cloud-based Farm Management System: Architecture and implementation. Department of Informatics and Telecommunications. University of Peloponnese, Tripolis, Greece

Kamara, A., Conteh, A., Rhodes, E. R. and Cooke, R. A. (2019). The relevance of smallholder farming to African agricultural growth and development. African Journal of Food, Agriculture, Nutrition and Development, 19(1), 14043–14065.

Kanoktanaporn, S., Diao, X., Matsushita, S., Aoyogi, Y., Briones, M. R., Jiang, J. A., Takeshima, H., Saeed, M., Hossain, S. T., Watanabe, K. and Parth, S. (2019). APO agricultural transformation framework, Asian Productivity Organization (APO), Tokyo.

Kariuki, J. G. (2011). The Future of Agriculture in Africa. The Pardee Papers, No. 015, August 2011. The Frederick S. Pardee Center for the Study of the Longer-Range Future, Boston University, Boston, Massachusetts. IBSN 978-1-936727-02-5

Kawulich, B. (2012). 'Selecting a research approach: Paradigm, methodology and methods,' in Doing Social Research: A global context, Publisher: McGraw Hill, Editors: C. Wagner, B. Kawulich, M. Garner

Khazieva, N., Khaziev, A. and Klyushina, E. (2018). Digital Society: The Experience of the Philosophical Understanding of a Problem. Journal of History Culture and Art Research, 7(4), 347-353. doi: http://dx.doi.org/10.7596/taksad.v7i4.1856

Khuhawar K., Jianqiu Z., Farkhunda S. and Ye, Y. (2014). Crush the Poverty by Information and Communication Technology. International Journal of Scientific and Technology Research, 3(4).

King, N. (2004). Using templates in the thematic analysis of text. SAGE Publications Ltd, https://doi.org/10.4135/9781446280119

Kirsten, J.F. and Van Zyl, J. (1998). Defining small-scale farmers in the South African context. Agrekon, 37(4): 560-571.

Kleine, D. (2010). ICT4What? Using the Choice Framework to operalitionalise the capability approach to development. Journal of International Development, 22(5), 674–692.

Knopf, A. (1999). Development as Freedom by Amarta Sen, New York. The Quarterly Journal of Austrian Economics, 3(1) (Spring 2000): 89–91

Kollmair, M., Gamper, S. F. and Juli (2002). The Sustainable Livelihoods Approach, Input Paper for the Integrated Training Course of NCCR, North-South Aeschiried.

Koonin, M. (2014). Validity and Reliability. In F. du Plooy-Cilliers, C. Davis, & R-M. Bezuidenhout (Eds.), Research Matters (p.252-261). Cape Town: Juta.

Korten, D. C. (1987). Third Generation NGO Strategies: A Key to People-centred Development People, World Development, Vol. 15, National Association of Schools of Public Affairs and Administration Supplement, Great Britain. pp. 145-159

Kothari, C. (2004). Research Methodology: Methods and techniques, New Age International

Kretzmann, J. P. and McKnight J. L. (1993). Building Communities from the Inside Out: A Path Toward Finding and Mobilizing a Community's Assets, Evanston, IL: Institute for Policy Research (1993), pp. 1-11

Krone, M. and Dannenberg, P. (2018). Analysing the effects of information and communication technologies (ICTs) on the integration of East African farmers in a value chain context. Zeitschrift für Wirtschaftsgeographie 62(1), 65-81. https://doi.org/10.1515/zfw-2017-0029

Kumar, D. and Rajeev, P. (2016). Value Chain: A Conceptual Framework. International Journal of Engineering and Management Sciences, 7(1), 74-77.

Lee A. S., Briggs R. and Dennis A. R. (2014). "Crafting Theory to Satisfy the Requirements of Explanation, " 2014 47th Hawaii International Conference on System Sciences, Waikoloa, HI, 2014, pp. 4599-4608, doi: 10.1109/HICSS.2014.566.

Lee H. L., Mendelson H. and Rammohan, S. (2017). Technology in Agribusiness-Opportunities to Drive Value, White Paper, August 2017. Stanford Value Chain Innovation Initiative, Stanford Graduate School of Business, United States.

Lee, A. S. (1991). Integrating Positivist and Interpretive Approaches to Organisational Research. In Organization Science, Vol. 2. No. 4. The Institute of Management Sciences, University of Cincinatti, USA. Pp 342-365

Lee, A. S. (2004). Thinking about social theory and philosophy for information systems. In J. Mingers and L. Willcocks (Eds.), Social Theory and Philosophy for information systems (pp. 1-26). Chichester, UK: Wiley.

Lezaun, J. (2017). 'Actor-network theory: Four nails in the coffin', in C. Benzecry, M. Krause and I. Reed (eds.), Social theory now. The University of Chicago Press, pp. 305–336, Chicago, Press.

Littrell, D. W. and Littrell, D. P. (2006). Practicing Community Development. Columbia, MO: University of Missouri Extension.

Loukos, P. and Javed, A. (2018). Opportunities in agricultural value chain digitisation: Learnings from Ghana. GSM Association. https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/01/

Mago, S. and Mago, S. (2015). Information and Communications Technologies (ICTs) and livelihoods enhancement in agriculture-rural communities in Zimbabwe: Connections using the capabilities approach. Department of Development Studies, University of Fort Hare, East London.

Mahalakshmi, P., Vimala, D. D. and Krishnan, M. (2008). Web kiosks in aquaculture: a study of aquachoupal model in Prakasam district of Andhra Pradesh, in Vasanthakumar, J.

Malan, N. (2018). The new agriculture and developing emerging farmers: Harnessing the fourth industrial revolution, viewed 26 February 2019, from https://www.dailymaverick.co.za/article/2018-12-09-the-new-agriculture-and-developing-emerging-farmers-harnessing-the-fourth-industrial-revolution/

Mamabolo, R. (2009). Chapter Three: Research Methodology, Pp 3-1 to 3-20 https://uir.unisa.ac.za/xmlui/bitstream/handle/10500/1962/04**chapter3**.pdf

Manikas, I. G., Malindretos, G. and Moschuris, S. (2019). A community-based agro-food hub model for sustainable farming. Journal for Sustainability, 11(4), 1017. Available at: https://doi.org/10.3390/su11041017

Martin, R. and Duncombe, R. (2017). Best practice for implementing mobile finance in low-income communities. Global Development Institute, Manchester.

Maru, A., Berne, D., De Beer, J., Pesce, V., Kalyesubula, S., Fourie, N., Addison, C., Collett, A. and Chaves, J. (2018). Digital and data-driven agriculture: Harnessing the power of data for smallholders, Global Forum on Agricultural Research and Innovation (GFAR), with Global

Open Data for Agriculture and Nutrition (GODAN) initiative and the Technical Centre for Agricultural and Rural Cooperation (CTA), Rome, Italy.

Mattern, M. and Ramirez, R. (2017). Digitizing value chain finance for smallholder farmers (Focus note 106). CGAP.

Matto, G. (2018). Agriculture information access and the use of ICTs among smallholder farmers: A case of Bembeke EPA in Dedza District, Malawi. Research Report Series, 2(1), 59-72.

Maung K. Sein, Thapa, D., Hatakka, M. and Sæbø, Ø. (2019). A holistic perspective on the theoretical foundations for ICT4D research, Information Technology for Development, 25:1, 7-25, https://doi.org/10.1080/02681102.2018.1503589

Maxwell, J. and Loomis, D. (2003). Mixed method design: An alternative approach. In A. Tashakkori and C. Teddle (Eds.), Handbook of mixed methods in social and behavioral research (pp. 241-272). Thousand Oaks, CA: Sage.

May, J. and Diga, K. (2015). Progress towards resolving the measurement link between ICT and poverty reduction. Journal: Impact of Information Society Research in the Global South, 83-104, 2015. 40. ICTD research by Africans: Origins, interests, and impact.

Mayra, M. F. (2012). Graduate Employability: What can Higher Education do? A Literature Review. University of Brighton, Brighton Business School, United Kingdom.

McKinney, M. and Harmon, W. (2007). Governing Nature, Governing Ourselves: Engaging Citizens in Natural Resource Decisions. The International Journal of Public Participation, I(2). Public Policy Research Institute, University of Montana, USA.

Melhem, S. and Jacobsen, A. H. (2020). A Global Study on Digital Capabilities. Policy Research Working Paper Series, The World Bank, Washington, USA. https://www.worldbank.org/en/topic/digitaldevelopment/brief/a-global-study-on-digital-capabilities

Merriam, S. B. (1998). Qualitative Research and Case Study Applications in Education. Jossey-Bass Publishers, San Francisco.

Mertens, D. M. (2007). Transformative paradigm: Mixed methods and social justice. Journal of Mixed Methods Research, 1(3), 212-225.

Mertens, D. M. (2009). Transformative research and evaluation. The Guilford Press, New York

Mertens, D. M. (2010). Transformative Mixed Methods Research. Qualitative Inquiry, 16(6), 469-474. doi:10.1177/1077800410364612

Mertens, D. M. (2012). Transformative Mixed Methods: Addressing Inequities. Vol 56, Issue 6. https://doi.org/10.1177/0002764211433797

Mertens, D. M. (2016). Advancing Social change in South Africa through Transformative. Article in South African Review of Sociology

Mertens, D. M. (2017). Transformative research: personal and societal. https://doi.org/10.1515/ijtr-2017-0001

Mertens, D. M. and McLaughlin, J. A. (2004). Research and Evaluations Methods in Special Education. Thousand Oaks, CA: Sage Publications. https://doi.org/10.4135/9781412985666

Mertens, D.M. and Hesse-Biber, S. (2013). 'Mixed Methods and Credibility of Evidence in Evaluation,' in Mertens, D.M. and Hesse-Biber, S., Eds., New Directions for Evaluation, Wiley, New York, 5-13. https://doi.org/10.1002/ev.20053

Mertler, C. C. and Charles, C. M. (2008). Introduction to Educational Research (7th ed.). Boston, MA: Pearson.

Mitrovic, Z. and Taylor, W. (2010). e-Skilling the Nation for the Information Society and Creative Knowledge Economies: e-Skills research funding mechanism for South Africa, The Information Society Institute (TISI) for the Department of Communications, RSA

Moher, D., Liberati, A., Tetzlaff, J. and Altman, D. G. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement, The PRISMA Group. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

Molla, A. and Al-Jaghoub, S. (2007). Evaluating digital inclusion projects: a livelihood approach, International Journal of Knowledge, and Learning, 3(6), 592-611

Morse, J. M. and Richards, L. (2002). Readme First for a User's Guide to Qualitative Methods. Thousand Oaks, CA: Sage Publications.

Mosimane, A. W. and Aribeb, K. M. (2005). Exclusion through defined membership in people centred natural resources management: Who defines? CASS/PLAAS Commons Southern Africa occasional paper; no. 14, Windhoek: University of Namibia. (Social Sciences Division of the Multi-Disciplinary Research Centre research report.)

Mouton J. and Marais H. C. (1998). Basic concepts in the methodology of the social sciences, Pretoria, South Africa: Human Sciences Research Council.

Mouton, J. (2001). How to Succeed in Your Master's and Doctoral Studies: A South African Guide and Resource Book. Van Schaik, Pretoria.

Munyua, H. (2007). ICTs and small-scale agriculture in Africa. A scoping study. IDRC. http://www.idrc.ca/uploads/user-S/12212542261Final_Report_HMunya.pdf

Musa, N. S., Githekho J. M. and El-siddig, K. (2013). The adoption and use of ICT by small-scale farmers in Gezira State, Sudan. International Journal of Trade, Economics and Finance, 4(2).

National Animal Health Forum (NAHF). (2017). An overview of Operation Phakisa, Available at http://nahf.co.za/an-overview-of-operation-phakisa-2017-04-07/

National Planning Commission (NPC). (2011). National Development Plan. Pretoria: Government Printers.

Nayyar D. and Chang H. (2005). The Development Imperative: Toward a People-Centred Approach. The International Forum for Development, Social Science Research Council University of Cambridge. pp 1-8

Ncube, B., (2018). Constraints to smallholder agricultural production in the Western Cape, South Africa. Physics and Chemistry of the Earth, Parts A/B/C, 106:89-96.

Ndemo, B. (2019). Toward the Transformative Power of Universal Connectivity. In Graham, M. (ed.). Digital Economies at Global Margins. International Development Research Centre, London, MIT Press

Nilsen, P. (2015). Making sense of implementation theories, models and frameworks. Implementation Sci 10, 53. https://doi.org/10.1186/s13012-015-0242-0

Nmadu, J., Aiyelitsoya, N. A. F. and Sallawu, H. (2013). Use of ICT in securing marketing information among small scale farmers in Niger State, Nigeria. International Journal of Trade, Economics and Finance, 4(2), 66-72. https://doi.org/10.7763/IJTEF.2013.V4.262

Nussbaum, M. C. (1988). Nature, Function and Capability: Aristotle on Political Distribution. Oxford Studies in Ancient Philosophy, Supl. Vol., 145.84.

Nussbaum, M. C. (2003). Capabilities as Fundamental Entitlement: Sen and Social Justice. Feminist Economics, 9(2-3), 33-59.

Odeyale, C. O. (2007). Balanced vertically integrated sustainability business model for reducing hunger and income-poverty in the shortest time possible. Journal of Sustainable Development in Africa, 9(1), 2007.

Odini, S. (2014). Access to and use of agricultural information by small scale women farmers in support of efforts to attain food security in Vihiga County, Kenya. Journal of Emerging Trends in Economics and Management Sciences, 5(2), 80-86. https://hdl.handle.net/10520/EJC152937

Onyango, K. (2016). The Role of Technology in Enhancing Livelihood Support. Director - Community Initiatives and Social Support Organization (CISSO), https://wikieducator.org/images/2/2b/PID_88.pdf

Organisation for Economic Co-operation and Development (OECD). (2019). Digital opportunities for trade in agriculture and food sectors, Joint Working Party on Agriculture and Trade, TAD/TC/CA/WP(2018)4/FINAL, OECD, Paris, France.

Ospina, A. V. and Heeks, R. (2016). Measuring and Intervening on Resilience: The RABIT Approach. Manchester, UK: Centre for Development Informatics, University of Manchester.

Ospina, A. V., Heeks, R., Camacho, K., Calvo, M., Zuniga, V., Barrios, P., Marin, K. and Rojas, I. (2016). Benchmarking urban community resilience. Resilience Assessment Benchmarking and Impact Toolkit (RABIT). Manchester, UK: Centre for Development Informatics, University of Manchester.

Ospina, A.V. (2018). Big Data for resilience storybook: Experiences integrating Big Data into resilience programming. Winnipeg: International Institute for Sustainable Development. Retrieved from www.iisd.org

Parkinson, S. and Ramirez, R. (2006). Using a sustainable livelihoods approach to assessing the impact of ICTs in development. Community Informatics, 2(3), 116-127

Partington, R. (2021). Youth unemployment: the young workers hit hard by the Covid crisis. Economics correspondent, The Guardian News and Media Limited. Available at: https://www.theguardian.com/society/2021/apr/21/youth-unemployment-the-young-workers-hit-hard-by-the-covid-crisis.

Paudel, K. P., Mishra, A. K., Pandit, M., Larkin, S., Rejesus, R. and Velandia, M. (2020). Modeling multiple reasons for adopting precision technologies: Evidence from U.S. cotton producers. Computers and Electronics in Agriculture, 175, 105625. https://doi.org/10.1016/j.compag.2020.105625.

Paudel, K. P., Pandit, M., Mishra, A. K. and Segarra, E. (2011). Why don't farmers adopt precision farming technologies in cotton production? (No. 321-2016-10736).

Penderis, S. P. (2012). Theorizing participation: from tyranny to emancipation. Journal of African and Asian Local Government Studies, 1(3), 1-28.

Pepper, R. and Jackman, M. (2019). 'A Data-Driven Approach to Closing the Internet Inclusion,' in Graham, M. (ed.). Digital Economies at Global Margins. International Development Research Centre, London, MIT Press

Pesce, M., Kirova, M., Soma, K., Bogaardt, M. J., Poppe, K., Thurston, C., Monfort Belles, C., Wolfert, S., Beers, G. and Urdu, D. (2019). Research for AGRI Committee – Impacts of the digital economy on the food-chain and the CAP, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels.

Peters, B. G. (2000). 'Institutional theory and public organizations', in G. Morand and P. Knopfel (eds.), Essays in Memory of Raimund Germann r18 – B. Guy Peters/ Institutional theory: Problems and prospects – I.H.S Peters and Pierre, (1998) Institutions and time;

problems of conceptualization and explanation. Journal of Public Administration Research and Theory, 8, 565-584.

Peterson, R. A. (1994). A meta-analysis of Cronbach's coefficient alpha. Journal of Consumer Research, 21(2), 381-391.

Pienaar, L. and Traub, L. (2015). "Understanding the smallholder farmer in South Africa: Towards a sustainable livelihoods classification," 2015 Conference, August 9-14, 2015, Milan, Italy 212633, International Association of Agricultural Economists.

Pionetti, C. and Bilgi, M. (2011). The Long Road from Household Food Security to Women's Empowerment: Signposts from Bangladesh and The Gambia. 12 Action Aid International Briefing.

Polakovic, G. (2020). How does coronavirus affect young people's psyches? The University of Southern California (USC) News. Available at: https://news.usc.edu/167275/how-does-coronavirus-affect-young-people-psyches/.

Pona, F. Z. (2002). People-centred Development in Practice: The case of Zikhova-Ngqinisa Sidibene Woodlot Trust Project. Master's Thesis, Department of Sociology and Industrial Sociology, Rhodes University, South Africa.

Pradhan S. K. (2013), IT Architecture Design Framework: ADMIT (Architecture Design (or Development) Methodology for Information Technology). In Enterprise Architecture topic, InfoQ, **https://www.infoq.com/articles/admit-architecture-framework/**

Pretty, J. (1995). Participatory learning for sustainable agriculture. World Development Report, 23(8), 1247-1263.

Principles of Digital for Development (PD4D) [Internet]. Available from: https://digitalprinciples.org/principles/

Quinones, G., Heeks, R. and Nicholson, B. (2017). The broad issues surrounding digital data, information, knowledge, information systems, and information and communication technologies in the process of socio-economic development, Development Informatics Paper 67, University of Manchester, UK http://www.gdi.manchester.ac.uk/research/publications/working-papers/di/

Ramiller, N. (2013). Reconsidering Resistance in the Post Human Era. School of Business Administration, Portland State University

Reardon, T., Barrett, C., B., Berdegué, J. A. Swinnen. and J. F. M. (2009). Agri-food Industry Transformation and Farmers in Developing Countries. World Development Report, 37(11), 1717-1727.

Ribeiro, R. (2021). 'Digital transformation: The evolution of the enterprise value chains', in X.S. Yang, R.S. Sherratt, N. Dey and A. Joshi (eds.), Proceedings of fifth international congress on information and communication technology, ICICT 2020, Advances in Intelligent Systems and Computing, vol. 1183, Springer, Singapore. https://doi.org/10.1007/978-981-15-5856-6_29

Richardson, D. (2012). How Can Agricultural Extension Best Harness ICTs to Improve Rural Livelihoods in Developing Countries? Senior Consultant, Communications & Consultation Canada

Ritchie, J., Lewis, J., Nicholls, C. M. and Ormston, R. (2013). Qualitative research practice: A guide for social science students and researchers. Sage.

Robeyns, I. (2005). Sen's capability approach to welfare economics. In W. Kuklys (Ed.), (pp. 9–30). Amartya Sen's capability approach theoretical insights and empirical applications (pp. 9–30). Berlin: Springer.

Rogers, E. M. (2003). Diffusion of Innovation (5th ed.). Free Press.

Romm, N. R. A. (2014). Exploring of Transformative Paradigm with a Pragmatic Twist to contribute to Educational change. International Journal on New Trends in Education and Their Implications, 5(2) Article: 12 ISSN 1309-624

Romm, N. R. A. (2015). Reviewing the Transformative Paradigm: A Critical Systemic and Relational (Indigenous) Lens, Article in Systemic Practice and Action Research, Department of Adult Education and Youth Development, University of South Africa, 28:411–427, DOI 10.1007/s11213-015-9344-5

Rose, D. C. and Chilvers, J. (2018). Agriculture 4.0: Broadening Responsible Innovation in an Era of Smart Farming. Frontiers in Sustainable Food Systems, 2 DOI: 10.3389/fsufs.2018.00087

Roth, D. and Metha, J. D. (2002). The Rashomon Effect: Combining Positivist and Interpretivist Approaches in the Analysis of Contested Events. Sociological Methods research. Sage, Pp 131-173.

Rudhumbu, N., Makambe, U., Mkali, O. and Ndlovu, B. (2016). Understanding Graduate Employability: A Case of a Selected University in Botswana. European Journal of Training and Development, 3(2), 1-16.

Sæbø, J. I. (2017). Overview of institutional theory, IN520 Lecture. Department of Informatics, University of Oslo, Oslo, Norway.

Salazar, M. and Holbrook, A. (2008). Some notes on theories of technology, society and innovation systems for science and technology policy studies. International Journal of Technology, Knowledge and Society, 2.

Saldana, J. (2013). The Coding Manual for Qualitative Researchers (2nd ed.). London: Sage.

Samii, R. (2008). Role of ICTs as enablers for agriculture and small-scale farmers. International Fund for Agricultural Development (IFAD). Joint Conference of IAALD, AFITA and WCCA World Congress August 24–27.

Sandberg, J. (2005). How Do We Justify Knowledge Produced Within Interpretive Approaches? Organizational Research Methods, 8(1). Sage Publications. Pp 41-68.

Sarkar, M., Overton, T., Thompson, C. and Rayner, G. (2016). Graduate employability: Views of recent science graduates and employers. International Journal of Innovation in Science and Mathematics Education, 24(3), 31-48. Available at: https://openjournals.library.sydney.edu.au/index.php/CAL/article/view/11043/10644.

Saunders M. N. K., Lewis P., Thornhill A. and Bristow A. (2019). "Research Methods for Business Students" Chapter 4: Understanding research philosophy and approaches to theory development. In book: Research Methods for Business Students, Edition: 8, Chapter: 4, Publisher: Pearson Education

Saunders, M., Lewis, P. and Thornhill, A. (2007). Research Methods for Business Students (4th ed.). Pearson Education Limited

Schenk, C. J. and Louw H. (1995). A People centred Perspective on People centred Community Development. Journal of Social Development in Africa, 81-91

Scoones, I. (1998) Sustainable Rural Livelihoods: A Framework for Analysis. Working Paper 72, Brighton, UK: Institute for Development Studies.

Sealey, D. (2018). Digital value chain: It's time for small-scale farmers to enter value chains, viewed 27 February 2020, from http://storm81.com/strategy/digital-value-chain.

Sein, M K., Thapa D., Hatakka M. and Sæbø, Ø. (2019). A holistic perspective on the theoretical foundations for ICT4D research. Information Technology for Development, 25(1), 7-25, DOI: 10.1080/02681102.2018.1503589

Sen, A. (1985). Well-being, agency and freedom: The Dewey lectures 1984. The Journal of Philosophy, 82(4), 169-221.

Sen, A. (1990. Justice: means versus freedoms. Philosophy and Public Affairs, 19, 111-121.

Sen, A. (1999). Development as freedom. Oxford University Press.

Sen, A. (2005). Human Rights and Capabilities. Journal of Human Development and Capabilities, 6( )2, 151-166.

Serrat, O. (2010). The sustainable livelihoods approach. Washington, DC: Asian Development Bank.

Shannon-Baker, P. (2016). Making Paradigms Meaningful in Mixed Methods Research. Journal of Mixed Methods Research, 10(4), 319-334. doi:10.1177/1558689815575861

Silverman, D. (2013). Doing Qualitative Research: A Practical Handbook. Sage Publications.

Singh, Y. (2006). Fundamental Of Research Methodology and Statistics. New Age International

Siregar, C. D. T. (2019). Technopreneurship among the youth as supporting factors for economic sustainability. Towards The Fourth Industrial Revolution. in ASEAN Notes by. ASEAN Studies Center UGM, Faculty of Social and Political Sciences, Universitas Gadjah Mada, Indonesia. Available at: https://asc.fisipol.ugm.ac.id/2019/ 10/ 09/technopreneurship-among-the-youth-as-supporting-factors-for-economic-sustainability-of-asean-towards-the-fourth-industrial-revolution/.

Sirimanne, S. (2022). What is 'Industry 4.0' and what will it mean for developing countries? Director of Technology and Logistics, UNCTAD FUTURE OF WORK, World Economic Forum, Available at: https://www.weforum.org/ agenda/2022/04/what-is-industry-4-0-and-could-developing-countries-get-left-behind/.

Smith, A. (1986). 'Inquiry into the Nature and Causes of the Wealth of Nations,' 'n Heilbroner, Robert L., ed. The Essential Adam Smith. W. W. Norton & Company, New York:

South African Government (SAG). (2012). The National Development Plan: Vision 2030 (NDP), adopted in 2012, Role of NDP 2030, South African Government, www.dpme.gov.za › news › Pages › Role_of_NDP2030.

South African Government (SAG). (2019). Let's grow South Africa together: Towards a 25 Year Review | South African Government, https://www.gov.za/documents/towards-25-year-review-8-nov-2019-0000

Stewart, F. and Deneulin, S. (2002). Amarta Sen's contribution to development thinking. Studies in Comparative International Development, 37(61), 61–70.

Stugeon, T. (2017). The 'New' digital economy and development, UNCTAD Technical Notes on ICT for Development No. 8. UNCTAD, Geneva, Switzerland.

Sule, A. M, Sanni, A. O, Ayanda, J. O. and Olowosegun, T. (2009). Use of Information and Communications technology tools (ICTs) in Fisheries/Aquaculture Extension Service delivery in Borgu Local Government area of Niger State. National Institute for Freshwater Fisheries Research, Newbussa, Niger State Nigeria

Sustainable Development Solutions Network (SDSN). (2015). Indicators and a Monitoring Framework for the Sustainable Development Goals: Launching a data revolution for the SDGs, A report for the Leadership Council of the Sustainable Development Solutions Network, Revised working draft (version 7), http://unsdsn.org/wp-content/uploads/2015/03/150320-SDSN-Indicator-Report.pdf.

Swanepoel, H. and De Beer, F. (2006). Community Development. Breaking the cycle of poverty. Fourth edition. Landsdowne: Juta and Co.

Tashakkori, A. & Teddlie, C. (2003). Handbook of Mixed Methods in Social and Behavioural Research. Thousand Oaks: Sage.

Tashakkori, A. and Creswell, J. W. (2008). Envisioning the Future Stewards of the Social-Behavioral Research Enterprise. Journal of Mixed Methods Research, 2(4), 291-295.

Tashakkori, A. & Teddlie, C. (2010). Sage handbook of mixed methods in social and behavioural research. SAGE Publications

Taylor, G. W. and Ussher, J. M. (2001). Making Sense of S&M: A Discourse Analytic Account. Sexualities, 4, 293 - 314.

Teddlie, C. and Tashakkori, A. (2009). Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Techniques in the Social and Behavioral Sciences. Thousand Oaks, CA Sage

Tembo, R. (2008). Information and Communication Technology Usage trends and factors in Commercial Agriculture. Degree Master of Technology, Business Information Systems. Faculty of Busines., Cape Peninsula University of Technology.

Thamaga-Chitja, J. M. and Morojele, P. (2014). The context of smallholder farming in South Africa: Towards a livelihood asset building framework. Journal of Human Ecology, 45(2), 147-155. https://doi.org/10.1080/09709274.2014.11906688

Thapa D. and Omland H. O. (2018). Four steps to identify mechanisms of ICT4D: A critical realism-based methodology. Electronic Journal of Information Systems in Developing Countries (EJISDC). (;84:e12054. https://doi.org/10.1002/isd2.12054

Thompson, L. (2008). Public participation on dam building in South Africa: a case study of the Berg Water Project. In Transformation: Critical Perspectives on Southern Africa. PLAAS: University of the Western Cape. pp. 1-27

Tran, T. T. (2016). Enhancing graduate employability and the need for university-enterprise collaboration. Journal of Teaching and Learning for Graduate Employability, 7(1), 58. DOI: 10.21153/jtlge2016vol7no1art598

Trochim, W. M. K. (2006). The Qualitative Debate. Research Methods Knowledge Base. http://www.socialresearchmethods.net/kb/qualmeth.php

Tshivhase, M., Turpin, M. and Matthee, M. (2016). The use of Sen's capability approach in ICT4D: an exploratory review. CONF-IRM 2016 Proceedings. 10. https://aisel.aisnet.org/confirm2016/10

Tuckett, A. G. (2005). Applying Thematic Analysis Theory to Practice: A Researcher's Experience. Contemporary Nurse, 19, 75-87. https://doi.org/10.5172/conu.19.1-2.75

Tuli, F. (2005). The Basis of Distinction between Qualitative and Quantitative Research in Social Science: Reflection on Ontological, Epistemological and Methodological Perspectives. Journal of Education and Science, 6(1), 97-108, Ethiopia. https://doi.org/10.4314/ejesc.v6i1.65364

Ungerer, M., Bowmaker-Falconer, A., Oosthuizen, C., Phehane, V. and Strever, A. (2018). The future of the Western Cape agricultural sector in the context of the Fourth Industrial Revolution (Synthesis report), The Western Cape Department of Agriculture (WCDoA), together with the University of Stellenbosch Business School (USB). Cape Town, South Africa.

United Nations Global Compact (UNGC). (2019). Project Breakthrough, PA Knowledge Limited. Available at: https://www.paconsulting.com/insights/2018/sustainability/united-nations-global-compact/

UNCTAD. (2020). Calibrating technology to tackle sustainable development challenges in Africa. United Nations Conference on Trade and Development (UNCTAD), Palais des Nations, 8-14, Av. de la Paix, 1211 Geneva 10, Switzerland. Available at: https://unctad.org/news/calibrating-technology-tackle-sustainable-development-challenges-africa

University College London (UCL). (2020). Towards a Technology Strategy for Sustainable Livelihoods. Public University in London, England, Available at: https://www.ucl.ac.uk/dpu-projects/drivers_urb_change/urb_infrastructure/pdf_appropriate_technology/UNDP_SL .

Unwin, T. (2019). Digital Economies at Global Margins: A Warning from the Dark Side. In Graham, M. (ed.). Digital Economies at Global Margins. International Development Research Centre, London, MIT Press

Van Voorhis, C. R. W. and Morgan, B. L. (2007). Understanding power and rules of thumb for determining sample sizes. Tutorials in Quantitative Methods or Psychology, 3(2), 43-50

Venkatesh, V., Bala, H. and Sykes, T. A. (2010). Impact of Information and Communication Technology Implementation on Employees' Job in India: A Multi-Method Longitudinal Field Study. Production and Operations Management 19(5), 591-613.

Venkatesh, V., Brown, S. and Bala, H. (2013). Bridging the Qualitative–Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information Systems. MIS Quarterly, 37(1), 21-54.

Vermesan, O. and Friess, P., Eds. (2013). Internet of Things—Converging Technologies for Smart Environments and Integrated Ecosystems. River Publishers, Denmark.

Vinz, S. (2022). What Is a Theoretical Framework? Guide to Organizing. Scribbr. https://www.scribbr.com/dissertation/theoretical-framework/

Vroegindewey R. and Hodbod J. (2018). The resilience of Agricultural Value Chains in Developing Country Contexts: A Framework and Assessment Approach. https://doi.org/10.3390/su10040916

Wall, J. D., Stahl, B. C. and Salam, A. F. (2015). Critical discourse analysis as a review methodology: An empirical example. Communications of the Association for Information Systems, 37(1), 11.

Walsham, G. (2017). ICT4D research: reflections on history and future agenda, Information Technology for Development Journal, 23(1), 18-41, DOI: 10.1080/02681102.2016.1246406

Walsham, G. (2020). ICT4D South-South and triangular cooperation in ICT4D, Electronic Journal of Information Systems in Developing Countries (EJISDC), DOI: 10.1002/isd2.12130

Weber, R. (2004). The Rhetoric of Positivism versus Interpretivism: A personal view. Editors' comments in Alleged Differences between Positivism and Interpretivism. MIS Quarterly Volume 28 Issue 1. MIS Research Centre, Minneapolis, MN, USA. Pp iii - xiii

Webster, J. and Watson, R. T. (2002). Analyzing the past to prepare for the future: Writing a literature review. MIS Quarterly 26(2), 13-23, Available at: http://www.jstor.org/stable/4132319

Wells T., (2012). "Sen's Capability Approach," in J. Feiser & B. Dowden, Erasmus University, Rotterdam, The Netherlands World Bank. Development Research Group (2009).

White, Sarah C. (1996). Depoliticising development: the uses and abuses of participation. Development in Practice, (1), 6-15.

Wiles, R., Crow, G. and Pain, H. (2011). Innovation in Qualitative Research Methods: A Narrative Review. Qualitative Research, 11, 587-604. https://doi.org/10.1177/1468794111413227

Williams, C. (2007). Research Methods. Journal of Business and Economic Research, 5, 65-72.

Wisdom, A., Baatjies, N., Biallas, M. O., Caire, D., Heitmann, S., Kasujja, A., Dueck-Mbeba, R., Mudiri, J., Naouar, R., Ndaw, C., Oulai, R., Ramji, M., Savonitto, B. and Wensley, M.

(2018). Digital financial services for agriculture. International Finance Corporation, World Bank Group.

World Inequality Database (WID). (2020). The source for global inequality data. Open access, high quality wealth and income inequality data developed by an international academic consortium. South Africa - World Inequality Database (WID), https://wid.world/country/south-africa

Yilmaz, K. (2013). Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences. European Journal of Education, 48(2), 311-325.

Zheng, Y. (2007). Exploring the value of the capability approach for e-development. Proceedings of the 9th international conference on Social Implications of Computers in Developing Countries, San Pablo.

Zheng, Y. and Walsham, G. (2007) Inequality of What? Social Exclusion in the e-Society as Capability Deprivation, Working Paper no.167, Information Systems Dept, LSE, London

Zikmund, W., Babin, B., Carr, J. and Griffin, M. (2013). Business Research Methods. 9th ed. Cengage, p.301.

APPENDIX A: QUESTIONNAIRE

UNIVERSITY *of the* WESTERN CAPE

EMS
Where your Future is our Priority

FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES
Department of Information Systems

SURVEY QUESTIONNAIRE
This survey is part of a research project for a student studying towards a PhD. We would like to know your opinion about the use of new digital technologies (Internet and mobile phones), and how these technologies could impact the resilience of [*SMALL-SCALE FARMERS*]. Your participation in this survey is anonymous, and the results will be used solely for the purposes of the research project. This research will not expose you to any harm because of your participation. The results of this survey will be shared with the participants through [*PLANNED DISSEMINATION OF FINDINGS*].

PART I

Characteristics of the Interviewee

1. Gender	**2. Age range**	**3. Occupation**
A. Female	A 15 to 25 years old	A Student
B. Male	B 26 to 35 years old	B Employed
	C 36 to 45 years old	C Retired
	D More than 46	D Unemployed
		E Other

PART II;

ICTs (access and perception)

4. Do you own a mobile?	**4.1 If yes, how many mobiles do you own?**	
A. Yes	A. 1	A. 3
B. No	B. 2	B. More than 3

4.2 What do you use the mobile for?	**4.3 In your opinion, what are the main benefits of using a mobile phone?**
A Make and receive calls	
B Send/receive text messages	
C Games	
D Internet	

Ⓔ Other	
4.4 In your opinion, what are the main disadvantages or problems of using a mobile phone?	
5. Do you have access to a computer with Internet?	**5.1 If yes, where do you access it?**
	Ⓐ Home
Ⓐ Yes	Ⓑ Internet Café/Telecentre
Ⓑ No	Ⓒ Public Library
	Ⓓ At family or friends'
	Ⓔ Other
5.2 What do you use the Internet for?	**5.3 In your opinion, what are the main benefits of using the Internet?**
Ⓐ E-mail	
Ⓑ Social networking	
Ⓒ Work-related research	
Ⓓ School homework	
Ⓔ Others	
5.4 In your opinion, what are the main disadvantages or problems of using the Internet?	
PART III **Resilience Attributes**	
ROBUSTNESS	
6. Do you access more or less information about the weather since you use a mobile phone or the Internet?	
Ⓐ More	
Ⓑ Doesn't know / No answer	
Ⓒ Less	
6.1 I use the mobile/Internet to access information that helps me prepare better for emergencies	
Ⓐ Agrees	
Ⓑ Doesn't know / No answer	
Ⓒ Disagrees	
6.2. I use the Internet and the mobile to report problems and emergencies to the institutions/authorities	**6.3 If the answer is yes, to which institutions?**
Ⓐ Agrees	
Ⓑ Doesn't know / No answer	
Ⓒ Disagrees	
SELF-ORGANISATION	

7. The Internet and the mobile have made it easier or more difficult to organise and participate in agriculture value chains?

Ⓐ Easier
Ⓑ Doesn't know / No answer
Ⓒ More difficult

8. Which social networks do you use and for what purpose?

Social Network	Usage (YES/NO)	YES: For what purpose?
Facebook		
Twitter		
Instagram		
Other:		

8.1 Technologies are helping to build trust among people

Ⓐ Agrees
Ⓑ Doesn't know / No answer
Ⓒ Disagrees

LEARNING

9.I have received training through the Internet (e.g. online courses)	**9.1 If yes, which online training have you received?**
Ⓐ Agrees	
Ⓑ Doesn't know / No answer	
Ⓒ Disagrees	
9.2 Since you have access to the mobile or the Internet, do you share more or less than before experiences about climate change impacts or emergencies in the community?	**9.3 Could you mention some examples?**
Ⓐ More	
Ⓑ Doesn't know / No answer	
Ⓒ Less	

9.4 Through the mobile phone or the Internet I identify ideas to make improvements in my community

Ⓐ Agrees
Ⓑ Doesn't know / No answer
Ⓒ Disagrees

REDUNDANCY

10. I use the mobile or the Internet to generate some additional money to my normal income (e.g. receive remittances, do business)	**10.1 I use the mobile or the Internet to obtain or provide help to my neighbours when there are problems or emergencies in the emerging agriculture sector.**
Ⓐ Agrees	Ⓐ Agrees
Ⓑ Doesn't know / No answer	Ⓑ Doesn't know / No answer
Ⓒ Disagrees	Ⓒ Disagrees

10.2 I use the mobile or the Internet to access resources in cases of emergency (e.g. government aid, donations)	
Ⓐ Agrees	
Ⓑ Doesn't know / No answer	
Ⓒ Disagrees	
RAPIDITY	
11. Has to have mobile or Internet access made it faster or slower accessing help in cases of emergency?	**11.1 I have access to early warning systems through the mobile or the Internet**
Ⓐ Faster	Ⓐ Agrees
Ⓑ Doesn't know / No answer	Ⓑ Doesn't know / No answer
Ⓒ Slower	Ⓒ Disagrees
11.2 The mobile allows me to organise support in case of a climatic event or an emergency in my emerging agriculture sector (e.g. organise support from neighbours, family, friends, institutions) faster than before.	
Ⓐ Agrees	
Ⓑ Doesn't know / No answer	
Ⓒ Disagrees	
SCALE	
12. Mobile/Internet access has allowed me to work with new groups or organisations from outside the emerging agriculture sector	**12.1 If yes, could you mention an example?**
Ⓐ Agrees	
Ⓑ Doesn't know / No answer	
Ⓒ Disagrees	
12.2 The mobile and the Internet have allowed me to get involved in projects related to emerging agriculture sector value chains	**12.3 If yes, which projects/groups?**
Ⓐ Agrees	
Ⓑ Doesn't know / No answer	
Ⓒ Disagrees	
12.4 With access to the mobile/Internet you interact/are in contact more or less than before with representatives of institutions? (e.g. cooperatives, ONGs, Committees, donors)	
Ⓐ More than before	
Ⓑ Doesn't know / No answer	
Ⓒ Less than before	
DIVERSITY AND FLEXIBILITY	

13. The mobile and the Internet allow me to get to know options and opportunities to improve my quality of life	**13.1 I use the mobile and the Internet to access innovative ideas that I can apply to improve my livelihood**
Ⓐ Agrees	Ⓐ Agrees
Ⓑ Doesn't know / No answer	Ⓑ Doesn't know / No answer
Ⓒ Disagrees	Ⓒ Disagrees
13.2 Access to the mobile/Internet has helped me to understand better different points of view about important issues	
Ⓐ Agrees	
Ⓑ Doesn't know / No answer	
Ⓒ Disagrees	
13.3 I use information that I obtain from the mobile/Internet to inform my decisions, more or less than before	
Ⓐ More than before	
Ⓑ Doesn't know / No answer	
Ⓒ Less than before	
EQUITY	
14. Mobile/Internet access has helped the poorer farmers in the emerging agriculture sector catch up with the richer ones. Can you give me an example?	**14.1 Has mobile/Internet access strengthened or weakened your sense of belonging to the emerging agriculture sector? Can you give me an example?**
Ⓐ Agrees	Ⓐ Strengthened it
Ⓑ Doesn't know / No answer	Ⓑ Doesn't know / No answer
Ⓒ Disagrees	Ⓒ Weakened it
14.2. I use the Internet to inform myself about activities/projects that are taking place in my emerging agriculture sector.	
Ⓐ Agrees	
Ⓑ Doesn't know / No answer	
Ⓒ Disagrees	
THANK YOU!	

APPENDIX B: INTERVIEW GUIDE

UNIVERSITY of the WESTERN CAPE

EMS
Where your Future is our Priority

FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES

Department of Information Systems

Structured Interview Guidelines: MICRO-/ MESO-Level Small-scale farmers Stakeholders

Assessment of ICTs' role in small-scale farmers' resilience

A. Local context

- What are the positive characteristics/strengths of small-scale farmers?
- What are the problems faced by small-scale farmers? And what are the external problems that do not originate from small-scale farmers, but that affect them?
- In the time that you have worked with small-scale farmers, what have been the situations of emergency or risk that you have had to face? For example, moments of crisis or disasters that needed to be overcome?

B. Role of climate and economic change impacts and local response

- In your experience, has there been any incident related to climate and economic change that has affected small-scale farmers?
- What was the response to those incidents? What did you do, why, and who helped you?
- Are there any measures that have been taken to prevent or mitigate those impacts in the future?

C. Small-scale farmers resilience attributes

Robustness

- In your opinion, are small-scale farmers prepared to respond to disasters or climatic and economic events/emergencies?
- Are there any physical infrastructure/physical measures that have been adopted for small-scale farmers to prevent damage in case of climatic and economic emergencies?
- Are small-scale farmers in contact with the institutions that operate in this area? (e.g. committees, authorities)? Do they coordinate actions with those institutions?
- How vulnerable is small-scale farmers' infrastructure and housing to the impact of climatic and economic emergencies or events?
- Do you know of any laws, policies that help to reduce the risk of small-scale farmers to climatic events?

Self-organisation

- What can you tell me about the capacity of small-scale farmers to organise among themselves, in case of crisis or problems?
- Is there a high or a low degree of trust among small-scale farmers?
- Are there social networks or networks of collaboration operating among small-scale farmers? How strong are those networks?
- Are you a member of local groups or associations?

Learning

- Do you think that small-scale farmers has learned from past experiences, for example in the case of natural disasters or climatic events? If yes, how did that learning took place? (for example, with the help of which tools or which groups)
- Is it common for people in small-scale farmers to share their experiences and their knowledge with each other? Or are they rather guarded with their knowledge?
- Has any training/awareness-raising activity about climate and economic change taken place for small-scale farmers? Do you know if those issues are taught to youth at school?
- Do you think that traditional knowledge/indigenous practices are being taken into account, or are being lost?

Redundancy

- Do small-scale farmers generally depend on a single income source, or do they have access to multiple sources? (e.g. do they sell different products, receive remittances)
- Among small-scale farmers, are there several institutions/organisations that work on the same issues? (for example, multiple cooperatives, multiple NGOs)
- If you were not able to access support from family and neighbours in times of emergency, who would you go to for help?
- Do small-scale farmers have the custom of saving money? In case of disasters or emergencies, do they have contingent financial resources that they can use?

Rapidity

- Do you consider that, in case of emergency or climatic events, small-scale farmers responds and acts rapidly?
- Do you consider that small-scale farmers can access resources swiftly? For example, immediate support from friends/institutions/insurance, in case of need?
- Do you know of any early warning system operating in this area?

Scale

- In your opinion, are small-scale farmers in contact with institutions/organisations that are not based in this area? For example, with institutions that operates at the regional or national level? Which institutions? For what purpose are they in contact?
- In situations of emergency or crisis, have small-scale farmers received support from institutions or groups that are not part of small-scale farmers?
- Do you know of any examples of associations or collaborative work between small-scale farmers, the private sector, NGOs and/or local/national authorities?

Diversity and Flexibility

- Do you consider that small-scale farmers adapts well to change? For example, to changes in the economic, political or environmental situation.
- In your opinion, do small-scale farmers identify options to do things differently from the past? For example, in cases of emergencies or disasters, do they look for options, or apply the same measures that they have always used?
- What are the main sources of information for small-scale farmers? Where do they access information?
- Do you think that small-scale farmers implements innovative practices? Can you give any examples?
- Do you consider that small-scale farmers see change as a threat or as an opportunity?

Equality

- In your opinion, are the decisions that affect small-scale farmers taken in a participative manner?

- Are there gaps among different small-scale farmers groups, for example between seniors and youth, or among people with higher and lower income?
- Do you consider that the needs and opinions of all small-scale farmers (including seniors, youth, women-headed households, the disabled, etc) are being heard and considered? (for example as part of small-scale farmers projects/initiatives, local organisations)

D. Role of ICTs (*to be adapted to the particular development intervention)

- In your opinion, what is the rate of usage or adoption of mobile phones in small-scale farmers? And of the Internet?
- What have been the main benefits of using ICTs in small-scale farmers? Has anything improved or changed for better, from the way it was in the past?
- Has anything worsened?
- What are the main challenges that exist locally to access and use the mobile phone? And the Internet? For example, do you face any difficulties when using these tools?
- When there have been climatic or economic emergencies or events [such as the ones you mentioned before…] have ICTs been used?
- For what purpose? What role did they play as part of small-scale farmers' response to those impacts?

E. ICTs and Resilience Attributes (*to be adapted to the particular development intervention)

How would you mark the contribution of ICT tools to the following resilience attributes of small-scale farmers? (Weak/Average/Strong)

APPENDIX C: PARTICIPANT INFORMATION AND CONSENT FORM

UNIVERSITY *of the* WESTERN CAPE

EMS
Where your Future is our Priority

FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES
Department of Information Systems
Information Sheet: Structured Survey

Project Title: Towards a framework for the adoption of a digital value chain for emerging farmers in South Africa

Dear Participant,

I am a doctoral student in the Department of Information Systems, of the Faculty of Economic and Management Sciences at the University of the Western Cape. I would like to invite you to take part in my research project entitled, '*Towards a digital value chain framework for small-scale farmers in South Africa',* being a study conducted at the University of the Western Cape, South Africa. The study is aimed at developing an improved digital value chain framework to assist small-scale farmers in agriculture-value chains in South Africa.

Study procedures: The study has four main phases. The first involves using a literature review to determine and propose a conceptual digital value chain framework. The second phase involves improving the compiled questionnaire using the dimensions of the conceptual digital value chain framework to conduct a survey to develop an improved digital value chain framework. The third phase involves conducting structured interviews with managers and experts from both Telecommunication and Agriculture industries to validate the developed digital value chain framework. The final step involves compiling the results of the findings for further interpretation and recommendations to develop an improved digital value chain framework.

Benefits: There are no direct benefits for participating in this study, however, the information that you provide might contribute towards an understanding of the research agenda.

Confidentiality: The information that I will obtain from you will be stored safely, although it will be shared with my supervisor and the departmental staff who are involved in this study. Excerpts from the survey may be included in the final dissertation and may also be published in journals. The survey will be conducted with utmost privacy and your name will not be written down or recorded anywhere. Furthermore, the study does not require you to disclose or name any specific individuals and you do not have to discuss any personal information that you do not feel comfortable talking about.

Risks: There is no major anticipated risk that will be encountered by your participation in this study.

Voluntary participation: Participation in this study is voluntary and you are under no obligation to participate in the survey. If you have any concerns with the way the research is being conducted me and my supervisor will be available for further clarification (contact details are given below).

Please feel free to ask any questions on any aspect of this study that is unclear to you.
Yours sincerely,

Researcher: Hermanus Smidt Email: 8403164@myuwc.ac.za	Supervisor: Prof. Osden Jokonya Email: ojokonya@uwc.ac.za

NOTE: This research project has received ethical approval from the Humanities & Social Sciences Research Ethics Committee of the University of the Western Cape, Tel. 021 959 2988, email: research-ethics@uwc.ac.za

FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES
Department of Information Systems

Consent Form: Structured Survey

Project Title: Towards a framework for the adoption of a digital value chain for small-scale farmers in South Africa

Researcher: Hermanus Smidt

By signing below, I agree to the following statements:

1) I have read and understood the attached information sheet giving details of the project.
2) I have had the opportunity to ask the researcher any questions that I had about the project and my involvement in it, and I understand my role in the project.
3) My decision to consent is entirely voluntary, and I understand that I am free to withdraw at any time without giving a reason.
4) I understand that data gathered in this project may form the basis of a report or other form of publication or presentation.
5) I have given the researcher permission to audio record the interview.
6) I understand that my name will not be used in any report, publication or presentation and that every effort will be made to protect my confidentiality.

Participant's Signature: ___________________________________ Date: _______________

Please fill in and return this page. Keep the letter above for future reference.

Please only sign this form if you agree to participate in the study.

Researcher: Hermanus Smidt

FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES
Department of Information Systems
Information Sheet: Structured Interview

Project Title: Towards a framework for the adoption of a digital value chain for small-scale farmers in South Africa

Dear Participant,

I am a doctoral student in the Department of Information Systems, of the Faculty of Economic and Management Sciences at the University of the Western Cape. I would like to invite you to take part in my research project entitled: Towards a digital value chain framework for small-scale farmers in South Africa being a study conducted at the University of the Western Cape, South Africa. The study is aimed at developing an improved digital value chain framework to assist small-scale farmers in agriculture-value chains in South Africa.

Study procedures: The study has three main phases. The first involves using a literature review to determine and propose a conceptual digital value chain framework. The second phase involves improving the compiled questionnaire using the dimensions of the conceptual digital value chain framework to conduct a survey to develop an improved digital value chain framework. The final step involves conducting structured interviews with farmers, managers and experts from both Telecommunication and Agriculture industries to validate the developed digital value chain framework. The final step involves compiling the results of the findings for further interpretation and recommendations to develop an improved digital value chain framework.

Benefits: There are no direct benefits for participating in this study, however the information that you provide might contribute towards an understanding of the research agenda.

Confidentiality: The information that I will obtain from you will be stored safely, although it will be shared with my supervisor and the departmental staff who are involved in this study. Excerpts from the interview may be included in the final dissertation and may also be published in journals. The interview will be conducted with utmost privacy and your name will not be written down or recorded anywhere. Furthermore, the study does not require you to disclose or name any specific individuals and you do not have to discuss any personal information that you do not feel comfortable talking about.

Risks: There is no major anticipated risk that will be encountered by your participating in this study.

Voluntary participation: Participation in this study is voluntary and you are under no obligation to participate in the interview. If you have any concerns with the way the research is being conducted me and my supervisor will be available for further clarification (contact details are given below).

Please feel free to ask any questions on any aspect of this study that is unclear to you.

Yours sincerely,

Researcher: Hermanus Smidt Email: 8403164@myuwc.ac.za	Supervisor: Prof. Osden Jokonya Email: ojokonya@uwc.ac.za

NOTE: This research project has received ethical approval from the Humanities & Social Sciences Research Ethics Committee of the University of the Western Cape, Tel. 021 959 2988, email: research-ethics@uwc.ac.za

UNIVERSITY of the WESTERN CAPE

EMS
Where your Future is our Priority

FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES

Department of Information Systems

Consent Form: Structured Interview

Project Title: Towards a framework for the adoption of a digital value chain for small-scale farmers in South Africa

Researcher: Hermanus Smidt

By signing below, I agree to the following statements:

1) I have read and understood the attached information sheet giving details of the project.
2) I have had the opportunity to ask the researcher any questions that I had about the project and my involvement in it, and I understand my role in the project.
3) My decision to consent is entirely voluntary, and I understand that I am free to withdraw at any time without giving a reason.
4) I understand that data gathered in this project may form the basis of a report or other form of publication or presentation.
5) I have given the researcher permission to audio record the interview.
6) I understand that my name will not be used in any report, publication or presentation and that every effort will be made to protect my confidentiality.

Participant's Signature: ____________________________________ Date: ________________

Please fill in and return this page. Keep the letter above for future reference.

Please only sign this form if you agree to participate in the study.

APPENDIX D: ETHICS CLEARANCE PERMISSION LETTER

UNIVERSITY *of the* WESTERN CAPE

60 YEARS *of hope, action & knowledge*

02 July 2020

Mr HJ Smidt
Information Systems
Faculty of Economics and Management Sciences

Ethics Reference Number: HS 20/3/32

Project Title: Towards a framework for the adoption of a digital value chain for emerging small-scale farmers in South Africa

Approval Period: 01 July 2020 – 01 July 2023

I hereby certify that the Humanities and Social Science Research Ethics Committee of the University of the Western Cape approved the methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report by 30 November each year for the duration of the project.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Director: Research Development
University of the Western Cape
Private Bag X 17
Bellville 7535
Republic of South Africa
Tel: +27 21 959 4111
Email: research-ethics@uwc.ac.za

NHREC Registration Number: HSSREC-130416-049

FROM HOPE TO ACTION THROUGH KNOWLEDGE.

APPENDIX E: CASE STUDY PROTOCOL

OBJECTIVES OF THE RESEARCH

The main objectives of the study are to develop and validate a digital value chain framework to assist small-scale farmers in agriculture-value chains in South Africa. The developed framework is expected to assist small-scale farmers with digital technology adoption in Agriculture Value Chains (AVCs). The study used a sequential explanatory mixed methods approach. The first quantitative phase based on a questionnaire assisted to cover more participants in the research phenomenon. The results from the quantitative phase were used to develop the interview protocol for the qualitative phase. The qualitative phase involved structured interviews with participants to obtain their perceptions of inconclusive results from the quantitative phase. The mixed methods approach is expected to offer more depth and breadth to the phenomenon than a single approach.

1. **Key issues on which the researcher focussed: -**
   - To develop a digital value chain framework to assist small-scale farmers with digital technology adoption in AVCs.
   - To validate the developed digital value chain framework amongst participants from organisations that work in the two district municipalities where the survey was done.

2. **FIELD PROCEDURES**

   - At least thirteen participants should be interviewed. They included youth and women farmers as well as Agriculture and technology extension, community development practitioners, leaders from co-operatives, a commodity organisation and international NGOs working in the sector. The triangulation is for the purposes of data validation by data source.
   - The participants also included senior managers.
   - Access to the information was obtained by introduction through a trusted intermediary.
   - Initial contact was made at the highest level possible.
   - Interviews were tape recorded with participants' consent.
   - Documentary evidence to support the verbal information wherever possible.
   - An attempt was made to secure multiple interviews per location so as to reduce travelling.

3. CASE STUDY QUESTIONS

The fundamental objective of the study is to develop and validate a digital value chain framework to assist small-scale farmers in AVCs of South Africa. The following research questions were addressed:

- What are the participants' perceptions of the developed digital value chain framework to assist small-scale farmers?
- How do participants differ on different constructs and variables of the developed I digital value chain framework to assist small-scale farmers?
- Why if any are the reasons for the participants to differ on some constructs of the
- developed digital value chain framework to assist small-scale farmers?
- What could be the reason for the difference in perceptions of participants on the constructs of the developed digital value chain framework to assist small-scale farmers?
- What are the implications of the findings on the developed digital value chain framework to assist small-scale farmers?

4. CASE STUDY REPORT GUIDELINE

The following are the major headings that were established as the key focal points of the case study report. These were established from the literature chapter so that they could be used as supplementary aids for the researcher in conducting structured interviews with the participants.

- Demographic variables showing characteristics and profile of the participants in the study.
- The ICT access variables showing the access and perception of participants to digital technology adoption.
- The robustness variable to assist with aligning digital technology adoption to resilience of small-scale farmers.
- The self-organisation variable to assist with aligning digital technology adoption to resilience of small-scale farmers.
- The learning variable to assist with aligning digital technology adoption to resilience of small-scale farmers.
- The rapidity variable to assist with aligning digital technology adoption to resilience of small-scale farmers.
- The scale variable to assist with aligning digital technology adoption to resilience of small-scale farmers.

- The diversity and flexibility variable to assist with aligning digital technology adoption to resilience of small-scale farmers.
- The equality variable to assist with aligning digital technology adoption to resilience of small-scale farmers.

5. FIELD PROCEDURE

- At least half of the participants should be interviewed from youth, women and organisations working with farmers. This triangulation is for purposes of data validation by data source.
- At least one participant should be a senior manager of the government extension services.
- Access to the information was obtained wherever possible by introduction through a trusted (gatekeeper) intermediary.
- Initial contact with the organisation was at the highest level possible
- A friendly gatekeeper or guide was found as soon as possible.
- Interviews were tape recorded with participants' consent.
- Documentary evidence was sought to support the verbal information wherever possible.
- An attempt was made to secure multiple interviews per visit, to reduce travelling time.
- As many as possible, small-scale farmers were engaged in general conversation about digital technology adoption in Agriculture Value Chains.

APPENDIX F: INTERVIEW TRANSCRIPT SAMPLE

UNIVERSITY of the WESTERN CAPE

EMS
Where your Future is our Priority

FACULTY OF ECONOMIC AND MANAGEMENT SCIENCES

Department of Information Systems

Structured Interview: Leader of small-scale farmer co-operative (Small-scale farmer: vegetables, pigs and sheep). Assessment of ICTs' role in small-scale farmers' resilience
A. Local context: *'Positive Characteristics include that we know how to farm. We only need to be given our own land. This will benefit the Community as we would create economic opportunities outside farming as well. Small-scale farmers will work the land and we will use successful harvest to create assets for our children.'* Problems – *'Eskom Electricity accounts are enormous. Some farmers are not paper qualified, and this creates conflict with those who are. Farmers are organised in a co-operative and works together as a group. Some individuals want to break away and this cause friction that can lead to legal challenges.* *Water is a scarce commodity although there is a lot of water. It is controlled by the Water Board and farmers must pay a lot of money for water to irrigate. Departments of Rural Development and Water needs to assist.'* *'Housing for Children on farms is a problem as farmers are not allowed to expand the housing on our farms. This leads to squatter camps and social ills.'* *'Planning as some do not plan, while others do not keep by the plans that was developed. Although the small-scale farmers are attempting to farm organic, we are still impacted by the chemicals and pesticides sprayed by bi Commercial farmers that surround our farms.'*
B. Role of climate and economic change impacts and local response. *'We know about Climate change from what we listen from the news and see on the TV. We have only experienced some drought and there were not enough resources made available for small-scale farmers. We react to heat warnings quickly by getting our animals into cover. '*
C. Small-scale farmers resilience attributes
Robustness *'Small-scale farmers always make sure that we are informed about any looming crises such as rainstorms. Know about the weather patterns in our area. Crises was not that bad yet. The only things is the rain and dew in the morning. We are well prepared. Infrastructure is not available and the little we have is very hard because of all the other challenges to maintain.'*
Self-organisation

'Small-scale farmers are good on organising themselves. We know each other's history, have walked a long way together and this have created a deep sense of trust amongst each other. Only when some farmers wanted to break away from the group (co-op) and wanted to do their own thing caused some mistrust but ultimately the trust was restored.'
Learning *'We learn from previous experiences and share our knowledge amongst each other. Traditional knowledge/ indigenous practices are still being used and we also share some of this knowledge with government departments. There was some Climate change training, but it was not enough. We need more continuous support and training as things are changing constantly. Kids are aware and talk about climate change which means we are taught about it at school. We need to be trained how to use new technologies.'*
Redundancy *'Income is a challenge as some inputs by farmers only make them get in any income from that in a few months. Some receive government grants while others must perform alternative labour to get extra income. The only people that assisted them in the past was Surplus Peoples Project (SPP).'*
Rapidity **There is no early warning system. The only way for them to respond is through listening to the news about the rain and heat on radio and television.**
Scale
Diversity and Flexibility *'We want to expand to commercial farmers as some of them could make it but do not have enough land and support. We are open to change. We always want more information and gets this from farming magazines. Some are not used to using digital technology. We are open and willing to use it if training and support is provided.,*
Equality *'The decisions get taken in a participative manner. There is a big gap between small-scale farmer groupings.'*
D. Role of ICTs (*to be adapted to the development intervention) **'***ICT plays a big role where we can do research about funding Instruments available. These days nothing can be done without the use of technology. Training needs to be provided. Cell networks needs to be upgraded as they provide apps on how to deal with Climate change.'*
E. ICTs and Resilience Attributes (*to be adapted to the particular development intervention) *'ICT tools can strengthen the resilience attributes of small-scale farmers.'*

APPENDIX G: CODING AND THEMATIC ANALYSIS SAMPLE

Leader of Farming co-operative rural codes and theme development:

Interview Transcript	Initial notes	Codes	Themes
Positive Characteristics include that we know how to farm.	Understand farming Indigenous knowledge	Robust	Resilience Attributes
We only need to be given our own land. This will benefit the Community as we would create economic opportunities outside farming as well. Small-scale farmers will work the land and we will use successful harvest to create assets for our children.	Do not have enough land to farm. Need bigger sizes to become commercially sustainable.	States Role supporting Resilience	Not enough Government Support to be sustainable (Land)
Eskom Electricity accounts are enormous.	High cost of electricity and the dependency on Eskom	Using renewable energy	SDGs
Some farmers are not paper qualified, and this creates conflict with those who are. Farmers are organised in a co-operative and works together as a group. Some individuals want to break away and this cause friction that can lead to legal challenges.	Lack of Self-organisation to speak with one voice	Self-organisation	Resilience Attributes
Water is a scarce commodity although there is a lot of water. It is controlled by the Water Board and farmers must pay a lot of money for water to irrigate. Departments of Rural Development and Water needs to assist.	Water is monopolised by Water Boards that charges high cost	States Role supporting Resilience.	Not enough Government Support to be sustainable (Water)
Housing for Children on farms is a problem as farmers are not allowed to expand the housing on our farms. This leads to squatter camps and social ills.	Small-scale farmers are not allowed to have more than 1 housing structure on farm or expand existing structure	States Role supporting Social issues.	Not enough Government Support for Social issues (Housing)
Although the small-scale farmers are attempting to farm organic, we are still impacted by the chemicals and pesticides sprayed by Commercial farmers that surround our farms	Those who benefitted in the past are still benefitting.	Transformation	Not enough Government Support (Transformatio n)
Planning as some do not plan, while others do not keep by the plans that was developed.	Lack of skills in Planning and Monitoring	Training	Institutional Support (Training)
We know about Climate change from what we listen from the news and see on the TV.	No training or awareness programs of Climate change	Climate change Training	Institutional Support (Training)

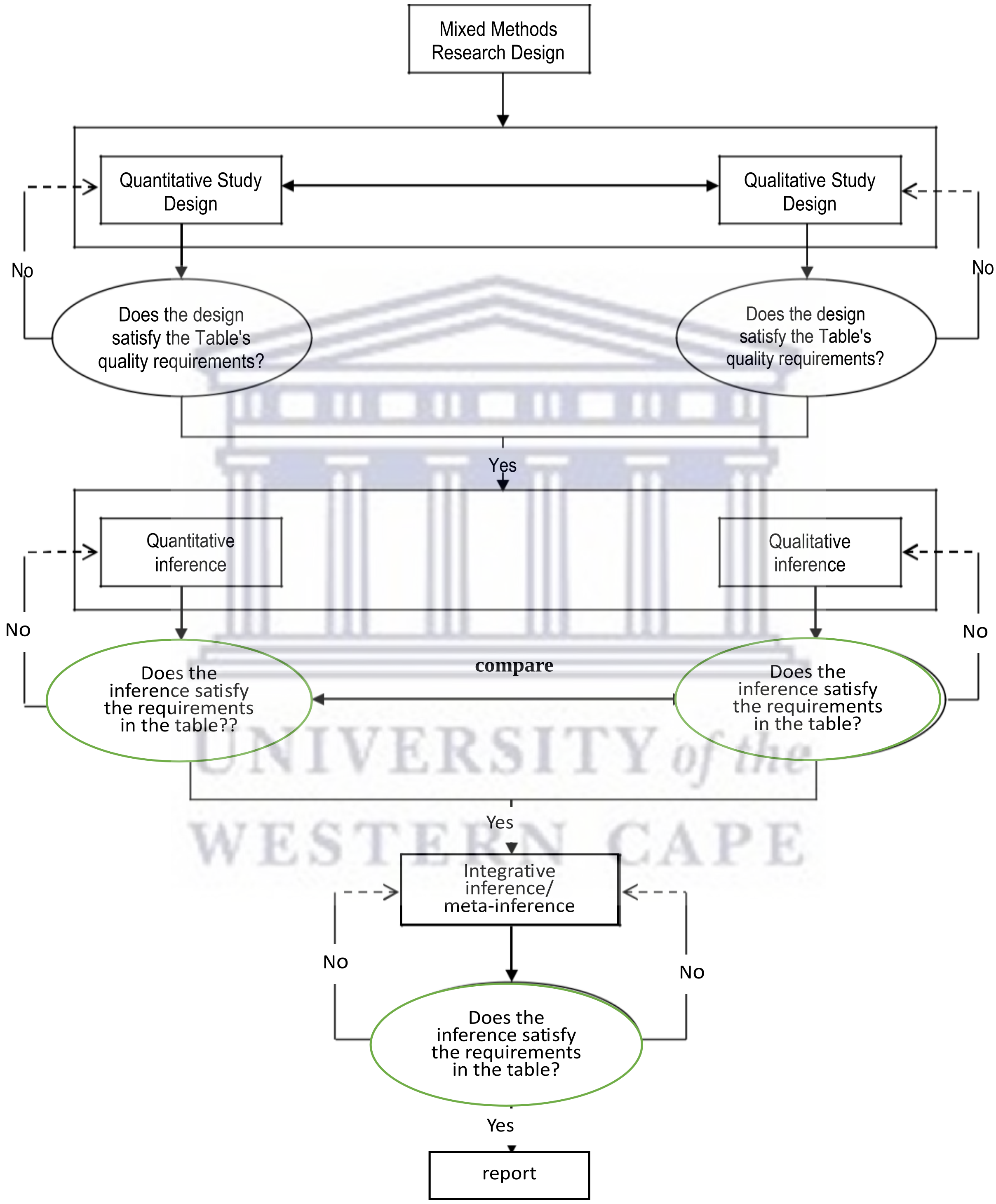
We have only experienced some drought and there were not enough resources made available for small-scale farmers.	There are not enough Climate Change Support for small-scale farmers	Climate change Support	Not enough Government Support (Climate change)
We react to heat warnings quickly by getting our animals into cover.	Respond fast to Climate change emergencies	Rapidity	Resilience Attributes
Small-scale farmers always make sure that we are informed about any looming crises such as rainstorms. Know about the weather patterns in our area. Crises was not that bad yet. The only things are the rain and dew in the morning. We are well prepared.	They are well-informed and prepare themselves for any crises.	Robustness	Resilience Attributes
Infrastructure is not available and the little we have is very hard because of all the other challenges to maintain.	Lack of Infrastructure support.	States Role supporting Resilience.	Not enough Government Support to be sustainable (Infrastructure)
Small-scale farmers are good at organising themselves.	Good at Self-organisation	Self-organisation	Resilience Attributes
We know each other's history, have walked a long way together and this have created a deep sense of trust amongst each other.	Good at trusting because of History	Self-organisation	Resilience Attributes
Only when some farmers wanted to break away from the group (co-op) and wanted to do their own thing caused some mistrust but ultimately the trust was restored.	Aspiration to make profits cause mistrust	Self-organisation	Resilience Attributes
We learn from previous experiences and share our knowledge amongst each other. Traditional knowledge/indigenous practices are still being used and we also share some of this knowledge with government departments.	They learn from the past and share knowledge	Indigenous Knowledge	Training
There was some Climate change training, but it was not enough. We need more continuous support and training as things are changing constantly. Kids are aware and talk about climate change which means they are taught about it at school.	Climate Training are given but need continuous local support and training.	Training	Institutional Support (Training)
We need to be trained how to use new technologies.	Training to use Digital technologies	ICTs and Resilience Attributes	Digital for development

Income is a challenge as some inputs by farmers only make them get in any income from that in a few months. Some receive government grants while others must perform alternative labour to get extra income.	Most Small-scale farmers not able to sustain themselves. They need alternative income	Redundancy	Resilience Attributes
The only people that assisted them in the past was Surplus Peoples Project (SPP).	Get some help from NGOs	Scale	Institutional Support
There is no early warning system. The only way for them to respond is through listening to the news about the rain and heat on radio and television.	No early warning systems to respond to crises.	Rapidity	Lack of Government support (Resilience).
We want to expand to commercial farmers as some of them could make it but do not have enough land and support.	States Role supporting to support commercialisation and expansion of farms.	Transformation	Not enough Government Support (Transformation)
We are open to change. We always want more information and gets this from farming magazines.	Respond fast with help of some neighbors to emergencies	Diversity and Flexibility	Resilience Attributes
Some are not used to using digital technology. We are open and willing to use it if training and support is provided.	Training to use Digital technologies	ICTs and Resilience Attributes	Digital for development
The decisions get taken in a participative manner.	Implements participatory decision making	Equality	Resilience Attributes
There is a big gap between small-scale farmer groupings	Issue of Monopolies. Lack of Transformation	Transformation	Farming monopolies
ICT plays a big role where they can do research about funding Instruments available. These days nothing can be done without the use of technology.	Digital technologies can play a big role in research for funding instruments.	ICTs and Resilience Attributes	Digital for development
Training needs to be provided. Cell networks needs to be upgraded as they provide apps on how to deal with Climate change.	Training to use Digital technologies	ICTs and Resilience Attributes	Digital for development
ICT tools strengthen the resilience attributes of small-scale farmers	Make small-scale farmers sustainable	ICTs and Resilience Attributes	Digital for development

APPENDIX H: SAMPLE INTERVIEW MATRIX ANALYSIS

	Interview Matrix Analysis						Date of Analysis							
	Inventory of concepts and informants													
	Use rows for concepts and columns for informants													
	Key Issues/Sources Matrix													
		P1	**P2**	**P3**	**P4**	**P5**	**P6**	**P7**	**P8**	**P9**	**P10**	**P11**	**P12**	**P13**
1	Transformation	X	X	X	X	X		X	X	x	X	X	X	X
2	Climate Impact	X												
3	Informal	X	X											
4	Self-organize	X	X	X	X	X	X	X	X	X	X	X	X	X
5	Redundancy	X	X	X	X	X	X	X	X	X	X	X	X	X
6	Learn	X		X					X			X	X	X
7	Training	X	X	X	X	X	X	X	X	X	X		X	X
8	Extension	X				X								
9	Diverse/Flexible	X	X	X	X		X	X	X		X	X	X	X
10	ICTs/Resilience	X	X	X	X	X	X	X	X	X	X	X	X	X
11	Rapidity	X			X	X	X	X	X	X	X	X	X	X
12	Equality	X	X			X	X	X	X		X		X	X
13	Climate change	X	X			X		X	X			X		
14	Robustness		X	X	X	X	X	X	X	X	X	X	X	X
15	Scale		X			X	X	X		X				
16	Climate/Training		X			X	X	X				X		X
17	Action/ Learn		X											
18	Indigenous/Intel		X		X	X	X	X	X		X			X
19	AVC-Essentials			X						X	X	X	X	
20	State-Resilience			X	X	X	X	X		X		X		
21	Action Research			X		X	X				X			
22	Digital/Extension			X										
23	Extension/Support				X	X		X	X		X		X	X
24	Climate/Fin sup				X		X							
25	Infrastructure/Lack						X							
26	Security/Lack						X					X		
27	Policies/Strategies/lack						X		X			X		
28	Renew\Load shedding							X		X		X	X	
29	Institutional support								X	X				
30	State/Social support					X			X					
31	Digital Food processing					X								
32	Knowledge and Intel					X								
33	Funding									X	X	X	X	
34	Research New Method									X				
35	Industrialization									X		X	X	
36	Organic farming									X				
37	Uni/Student Research									X		X		
38	Alternative Economy										X			
39	Sustainability (SDGs)										X		X	
40	Digital/Platform (D4D)										X	X		
41	Economic crises											X		
42	Innovation Hub											X	X	
43	Communication											X		
44	Duplication											X		
45	Culture sensitive											X		
46	Climate Infrastructure													X

APPENDIX I: AN INTEGRATIVE FRAMEWORK -MIXED METHODS



Integrated Framework for the Quality of Mixed Methods Inference		
Aspects of Quality	**Criteria for Quality**	**Description**
Design quality: The extent to which a researcher chose the most suitable techniques to address the research questions.	***Design feasibility / relevance***	The extent to which the research design and methodologies used are suitable for addressing the research issue. For instance, researchers must decide whether to perform mixed-methods research sequentially or concurrently, and they must choose the right quantitative (such as survey) and qualitative (such as interview) procedures.
	Design suitability	***Quantitative:*** The level of rigor and acceptable quality with which the design elements for the quantitative section (such as sampling, measures, and data collection techniques) are implemented. Reliability and internal validity are examples of quality indicators of inference.
		Qualitative: The extent to which the qualitative design elements are applied with respectable discipline and quality. Credibility and reliability are two markers of the inference's quality.
	Analytic suitability	***Quantitative:*** The extent to which the quantitative data analysis techniques and tactics are suitable and sufficient to offer logical responses to the research questions. Validity of statistical conclusions is a measure of inference quality.
		Qualitative: How well-suited and sufficient qualitative data analysis techniques and tactics are to offer believable responses to the research objectives. The theoretical plausibility and validity are examples of quality indicators.
Explanation quality: The extent to which reliable interpretations have been made based on the information obtained.	***Quantitative inferences***	The extent to which the conclusions drawn from the quantitative analysis are generalizable, consistent with theory, and closely aligned with pertinent facts. Internal validity, statistical conclusion validity, and external validity are all examples of quality indicators.
	Qualitative inferences	The degree to which conclusions drawn from the qualitative analysis are transferrable, closely associated with the relevant evidence, and supported by theory and the body of knowledge in the field. Credibility, verifiability, and transferability are examples of quality indicators.
	Integrative inference/ meta-inference	***Integrative efficacy:*** The extent to which conclusions drawn from each component of a mixed-methods research investigation are successfully combined to produce a meta-inference that is theoretically sound.
		Inference transferability: The extent to which meta-inferences drawn from mixed-methods research can be applied to different situations or circumstances.
		Integrative correspondence*:* How well mixed-methods research meta-inferences fulfil the original goal of employing a mixed-methods approach

Source: Adapted from Venkatesh et al. 2013

APPENDIX J: ANALYSIS OF VARIANCE (ANOVA)

Multiple Comparisons

ANOVA

			F	Sig.
Use Internet to assist with development in Community	LEACOMM	Learning	5.134	0.002
Use technology to assist neighbours	REDHEL	Redundancy	3.962	0.009
Faster Access to Emergency aid	RAPEMER	Rapidity	3.979	0.009
Sense of belonging to emerging AVCs	RAPEAR	Rapidity	5.372	0.002
Technologies assist in organising support for disasters	RAPSUPP	Rapidity	5.640	0.001
Work within groups	SCAGRO	Scale	2.678	0.049
Interact more with Institutions	SCAINST	Scale	7.532	0.000
Technology create new opportunities	DIVLIFE	Diversity and Flexibility	5.453	0.001
Understand different point of views better	DIVVIEW	Diversity and Flexibility	3.175	0.026
Info from technology influence decisions	DIVINFO	Diversity and Flexibility	5.064	0.002
D4D help poor farmers to catch up with richer farmers	EQUAGRI	Equity	5.504	0.001
Sense of belonging to emerging AVCs	EQSTREN	Equity	2.984	0.033
Info Emmerging Agriculture Sector	EQUPROJ	Equity	7.656	<,001

ANOVA

			F	Sig.
Access info for emergencies (Robustness)	Robemer	Robustness	3.368	0.020
Report problems and emergencies	Robreport	Robustness	3.417	0.019
Easier access to value chains	SELFVC	Self-Organisation	3.713	0.013
Technologies build trust	SELTRUST	Self-Organisation	4.753	0.003
Received training via internet	LEATRA	Learning	8.459	<,001
Use technology to generate extra money	REDINC	Redundancy	3.203	0.025
Use technology to assist neighbours	REDHEL	Redundancy	5.843	0.001
Access Resources for emergencies	REDEMER	Redundancy	4.182	0.007
Faster Access to Emergency aid	RAPEMER	Rapidity	4.452	0.005
Access to early warnings	RAPEAR	Rapidity	14.851	<,001
Technologies assist in organising support for disasters	RAPSUPP	Rapidity	5.454	0.001
More involve in AVC projects	SCAPROJ	Scale	5.085	0.002
Interact more with Institutions	SCAINST	Scale	10.300	<,001
Understand different point of views better	DIVVIEW	Diversity and Flexibility	7.553	<,001
Info from technology influence decisions	DIVINFO	Diversity and Flexibility	4.073	0.008
D4D help poor farmers to catch up with richer farmers	EQUAGRI	Equity	8.370	<,001
Sense of belonging to emerging AVCs	EQSTREN	Equity	5.229	0.002
Info Emmerging Agriculture Sector	EQUPROJ	Equity	14.078	<,001

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Technologies build trust	Between Groups	6.539	3	2.180	3.590	0.015
Received training via internet	Between Groups	7.766	3	2.589	4.495	0.005
Exchange more info about Climate Change	Between Groups	4.419	3	1.473	5.734	<,001
Use Internet to assist with development in Community	Between Groups	7.601	3	2.534	5.134	0.002
Use technology to assist neighbours	Between Groups	4.644	3	1.548	3.962	0.009
Faster Access to Emergency aid	Between Groups	0.728	3	0.243	3.979	0.009
Access to early warnings	Between Groups	4.728	3	1.576	5.372	0.002
Technologies assist in organising support for disasters	Between Groups	5.357	3	1.786	5.640	0.001
Work within groups	Between Groups	4.290	3	1.430	2.678	0.049
Interact more with Institutions	Between Groups	5.218	3	1.739	7.532	<,001
Technology create new opportunities	Between Groups	0.890	3	0.297	5.453	0.001
Understand different point of views better	Between Groups	3.337	3	1.112	3.175	0.026
Info from technology influence decisions	Between Groups	4.878	3	1.626	5.064	0.002
D4D help poor farmers to catch up with richer farmers	Between Groups	8.374	3	2.791	5.504	0.001
Sense of belonging to emerging AVCs	Between Groups	2.154	3	0.718	2.984	0.033
Info Emmerging Agriculture Sector	Between Groups	16.424	3	5.475	7.656	<,001

ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Access info for emergencies (Robustness)	Between Groups	3.149	3	1.050	3.368	0.020
Report problems and emergencies	Between Groups	2.884	3	0.961	3.417	0.019
Easier access to value chains	Between Groups	2.664	3	0.888	3.713	0.013
Technologies build trust	Between Groups	8.479	3	2.826	4.753	0.003
Received training via internet	Between Groups	13.656	3	4.552	8.459	<,001
Use technology to generate extra money	Between Groups	5.858	3	1.953	3.203	0.025
Use technology to assist neighbours	Between Groups	6.626	3	2.209	5.843	0.001
Access Resources for emergencies	Between Groups	5.217	3	1.739	4.182	0.007
Faster Access to Emergency aid	Between Groups	0.808	3	0.269	4.452	0.005
Access to early warnings	Between Groups	11.217	3	3.739	14.851	<,001
Technologies assist in organising support for disasters	Between Groups	5.197	3	1.732	5.454	0.001
More involve in AVC projects	Between Groups	8.052	3	2.684	5.085	0.002
Interact more with Institutions	Between Groups	6.819	3	2.273	10.300	<,001
Understand different point of views better	Between Groups	7.355	3	2.452	7.553	<,001
Info from technology influence decisions	Between Groups	3.993	3	1.331	4.073	0.008
D4D help poor farmers to catch up with richer farmers	Between Groups	12.131	3	4.044	8.370	<,001
Sense of belonging to emerging AVCs	Between Groups	3.627	3	1.209	5.229	0.002
Info Emmerging Agriculture Sector	Between Groups	27.266	3	9.089	14.078	<,001

APPENDIX K: STEPWISE REGRESSION ANALYSIS (T-TEST)

Independent Variable	Dependent Variable	F value	Significance Two-Sided p	Categories
			Significance	
		t	Two-Sided p	Categories
Gender	Access Weather information (Robustness)	2.774	0.006	Male or Female
	Report problems and emergencies	4.247	<,001	
	Received training via internet	-2.105	0.037	

Independent Samples Test

				Significance
		F	t	Two-Sided p
Access Weather information (Robustness)	Equal variances assumed	35.800	2.774	0.006
Report problems and emergencies	Equal variances assumed	11.410	4.247	<,001
Received training via internet	Equal variances assumed	0.247	-2.105	0.037

Own a mobile

Independent Samples Test

		Equality of Variances		t-test for Equality of Means
				Significance
		F	t	Two-Sided p
Received training via internet	Equal variances assumed	6.306	2.206	0.029
Faster Access to Emergency aid	Equal variances assumed	6.353	-2.456	0.015

Independent Samples Test

		Equality of Variances		t-test for Equality of Means
				Significance
		F	t	Two-Sided p
Exchange more info about Climate Change	Equal variances assumed	357.517	2.364	0.026
Use technology to assist neighbours	Equal variances assumed	0.649	2.696	0.012
Technologies assist in organising support for disasters	Equal variances assumed	24.927	4.294	0.000
Interact more with Institutions	Equal variances assumed	22.644	4.287	0.000
Technology create new opportunities	Equal variances assumed	293.276	3.425	0.002
Innovation to improve livelihood	Equal variances assumed	58.655	2.553	0.017
Understand different point of views better	Equal variances assumed	58.655	2.553	0.017
Info from technology influence decisions	Equal variances assumed	8.094	3.297	0.003

Independent Samples Test

		Equality of Variances		t-test for Equality of Means
				Significance
		F	t	Two-Sided p
Exchange more info about Climate Change	Equal variances assumed	6.059	-3.465	0.001
Use Internet to assist with development in Community	Equal variances assumed	13.551	-3.381	0.001
Use technology to generate extra money	Equal variances assumed	7.432	-2.418	0.017
Technologies assist in organising support for disasters	Equal variances assumed	46.588	-2.874	0.005
Work within groups	Equal variances assumed	0.177	-2.012	0.046
More involve in AVC projects	Equal variances assumed	2.669	-2.127	0.035
Interact more with Institutions	Equal variances assumed	27.621	-2.011	0.046
D4D help poor farmers to catch up with richer farmers	Equal variances assumed	0.224	-3.399	0.001
Sense of belonging to emerging AVCs	Equal variances assumed	10.975	-1.853	0.066
Info Emmerging Agriculture Sector	Equal variances assumed	0.921	-3.473	0.001

employed/retired

Independent Samples Test

		Equality of Variances		t-test for Equality of Means
				Significance
		F	t	Two-Sided p
Access Weather information (Robustness)	Equal variances assumed	2.859	-3.350	0.001
Access info for emergencies (Robustness)	Equal variances assumed	1.362	-2.467	0.015
Easier access to value chains	Equal variances assumed	259.750	-6.189	0.000
Technologies build trust	Equal variances assumed	23.810	-4.674	0.000
Received training via internet	Equal variances assumed	6.103	-7.270	0.000
Exchange more info about Climate Change	Equal variances assumed	6.868	-3.753	0.000
Use technology to generate extra money	Equal variances assumed	0.551	-2.815	0.005
Faster Access to Emergency aid	Equal variances assumed	24.598	2.431	0.016
Access to early warnings	Equal variances assumed	24.185	2.519	0.013
Technologies assist in organising support for disasters	Equal variances assumed	53.655	-3.275	0.001
Work within groups	Equal variances assumed	5.186	-3.831	0.000
More involve in AVC projects	Equal variances assumed	1.637	-3.137	0.002
Interact more with Institutions	Equal variances assumed	27.660	-3.254	0.001
Understand different point of views better	Equal variances assumed	72.432	-3.606	0.000
	Equal variances not assumed		-4.881	0.000
D4D help poor farmers to catch up with richer farmers	Equal variances assumed	2.201	-3.020	0.003
Sense of belonging to emerging AVCs	Equal variances assumed	22.970	-3.088	0.002
Info Emmerging Agriculture Sector	Equal variances assumed	25.123	-8.574	0.000

Unemployed/other

Independent Samples Test

		Equality of Variances		t-test for Equality of Means
				Significance
		F	t	Two-Sided p
Access Weather information (Robustness)	Equal variances assumed	8.328	2.090	0.039
Technologies build trust	Equal variances assumed	53.870	2.853	0.005
Received training via internet	Equal variances assumed	4.111	4.611	0.000
D4D help poor farmers to catch up with richer farmers	Equal variances assumed	27.989	2.943	0.004
Sense of belonging to emerging AVCs	Equal variances assumed	132.838	2.486	0.014
Info Emmerging Agriculture Sector	Equal variances assumed	36.764	4.069	0.000